ASBP The Alliance for Sustainable Building Products

Reuse Now Campaign

The Reuse of Glass Partitioning Systems

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FOREWORD

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This guide provides advice for clients, designers, specifiers and other economic operators throughout the supply chain on how to approach the reuse of glass partitions. It does this not just from the perspective of new projects with reuse requirements, but also from the perspective of designing projects to be more reuseable during the fit-out cycle.

Some construction products such as raised access floors and suspended ceiling tiles have already seen successful reuse models both in traditional fit-out environments, and in contemporary reuse initiatives. Glazed partitions have their own hurdles to reuse but should be treated no differently in terms of our ambition to specify and design reuse into our norms, and into the buildings which we all use.

Starting with an analysis of the situation we find ourselves in backed by rigorous data, this guide moves to give real world practical advice to those looking at reuse, asking the right questions and designing the right process to embed the reuse requirement into a project, and pre-empt hurdles before they are presented. This is crucial to ensure that reuse doesn't present a cost that the supply chain will be incentivised to value engineer away. Guidance then turns to the delivery and asset phase, providing valuable insights into how fit-out and strip-out contractors should engage with the unique logistics of a reuse scheme. Crucially, it covers how manufacturers have a key role to play throughout the process in ensuring that product can be safely deconstructed, stored, transported and reconstructed whilst maintaining or revalidating essential performance characteristics.

It is clear that the more ambitious embodied carbon limits found in the Net Zero Carbon Building Standards can only be achieved if the industry puts reuse of construction products front and centre. We must learn to standardise, normalise and ultimately industrialise the reuse of all construction products wherever achievable in order to meet the demands of the industry in years to come.

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Front cover image credit: Optima. Demountable system with bulkhead

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1: SUMMARY & RECOMMENDATIONS

Glass partitioning systems are widely used in commercial fit-outs and are generally removed and disposed of during the process of refurbishment or demolition. The reuse of these partitions in-situ or on other projects off site is minimal. Furthermore, despite its recyclability, end-of-life building glass is also almost never recycled into new glass products. Instead, it is often crushed together with other building materials and either goes to landfill with inert waste or is downcycled for low-grade fill application uses. Recent best practice has only resulted in 6% of flat glass being effectively recycled. Most of this glass is downcycled, i.e. turned into lower-quality products such as glass bottles and glass wool insulation.

Together with improved manufacturing yield, the reutilisation of end-of-life flat glass as cullet in new production could reduce the annual greenhouse gas emissions of the UK flat glass value-chain by up to 18.6%.

Processes to support reuse

- Data – material passports to support take back and/or reuse; more monitoring and collation of statistics regarding the reuse of construction glass
- Early engagement, materials audit as soon as refurb/deconstruction is being thought about, clear direction to all the team that reuse is a key deliverable for the project
- Glass partitioning to be reused in-situ if relevant, if not then find a recipient as soon as possible to incentivise the process, if not then donate as stock to a third party
- If some or all of partitioning system can't be reclaimed for reuse then look to reusing doors and 'closed-loop' recycling the rest of the system

Policies to move away from downcycling and landfill

- Incentives – planning benefits, carbon credits, procurement/tender requirements
- Penalties – higher landfill tax in conjunction with embodied carbon levies.

Is the reuse of glass partitioning possible?
Yes definitely

Does the reuse of glass partitioning offer carbon savings?
Yes definitely

Is the reuse of glass partitioning financially feasible?
Yes in some cases

Will it become more financially feasible the more clients demand it and the more instances of reclamation and reuse there are? (economies of scale and improved processes & skills)
YES!

2: UK GLASS - CURRENT SITUATION

The reuse of flat glass is not a common occurrence in the construction industry. The *2024 DESNZ report, Unlocking Resource Efficiency*, states that no literature data were available on current levels of reuse of construction flat glass, but that some of their workshop participants had known of ‘very small amounts of reuse’. The report cited the renovation of the Empire State Building, Lloyd's building and One Triton Square to demonstrate that the reuse of end-of-life insulated glazing was ‘technically feasible, despite complex assembly’; and Optima is mentioned as ‘offering a reuse service that allows for previously installed Optima glass partitions and doors into their new designs, facilitated by a modular design’. Key barriers to reuse were stated as lack of material passports and lack of standardisation.

Glass is 100% – and infinitely – recyclable (as long as its clean).

Despite its recyclability, end-of-life building glass is almost never recycled into new glass products. Instead, it is often crushed together with other building materials and either goes to landfill or is downcycled for low-grade fill application uses. Recent best practice has only resulted in 6% of flat glass being effectively recycled. Most of this glass is downcycled, ie. turned into lower-quality products such as glass bottles and glass wool insulation(1).

The majority of UK glass production is container glass, followed by flat glass. In 2019, the UK produced 950,000 of flat glass (23% of production) (2). The UK has three flat glass plants, with approximately three quarters of production being devoted to glazing products for buildings (2). The UK consumed 15.3 million m² of insulating glazing in 2013 (60% for renovation purposes) (3).

In 2019, the UK glass industry emitted 1.5 million tonnes of CO2 emissions, with 75-85% accounted for by fossil fuel combustion in the furnace (to produce the heat to melt the raw materials), and 15-25% as CO_2 emitted from the raw materials during the manufacturing process’ chemical reaction, depending on the amount of recycled cullet used (recycled cullet does not release CO_2 when remelted). The sector accounts for around 3% of UK industrial greenhouse gas (GHG) emissions (2).

British Glass has estimated that 750,000 tonnes of end-of-life waste flat glass is generated annually in the UK – around 500,000 tonnes of which is landfilled, the rest was primarily recycled for use as aggregates in construction (4).

(1) How reusing and recycling glass can cut a building’s carbon emissions, (2024)
(2) Unlocking Resource Efficiency Phase 2 Glass Report, April 2024 - DESNZ Research Paper Series Number 2024/008
(3) Economic study on recycling of building glass in Europe (2016)
(4) Glass sector Net zero strategy 2050 (2020)

(see Further Reading for full references)

2: UK GLASS - CURRENT SITUATION

Overall, while there is no indication from the UK glass industry of an impending critical shortage, there is, however, considerable uncertainty regarding the long-term security of raw materials, including silica sand supply, to support the manufacturing of glass within the UK and the industry would certainly welcome additional supply options (5).

9.2 million m^2 of glazing was replaced in the UK in 2013.

107,000 tonnes of glass per year was removed during residential refurbishment, and 62,000 tonnes in tertiary buildings per year.

7,000 tonnes was removed from the demolition of residential buildings, and 23,000 tonnes in tertiary buildings. (199,000 tonnes in total across all categories per year) (5).

The reuse of glass is the optimum solution, saving maximum resources and creating minimum additional carbon emissions (eg. packaging, logistics, reinstallation)...

...but closed-loop recycling also has huge benefits. Recycling one tonne of glass saves up to 300kgCO_2e and 1.2 tonnes of raw materials - including 700kg of sand. Cullet also melts faster than raw materials, resulting in up to a 30% saving in energy consumption and related emissions (6).

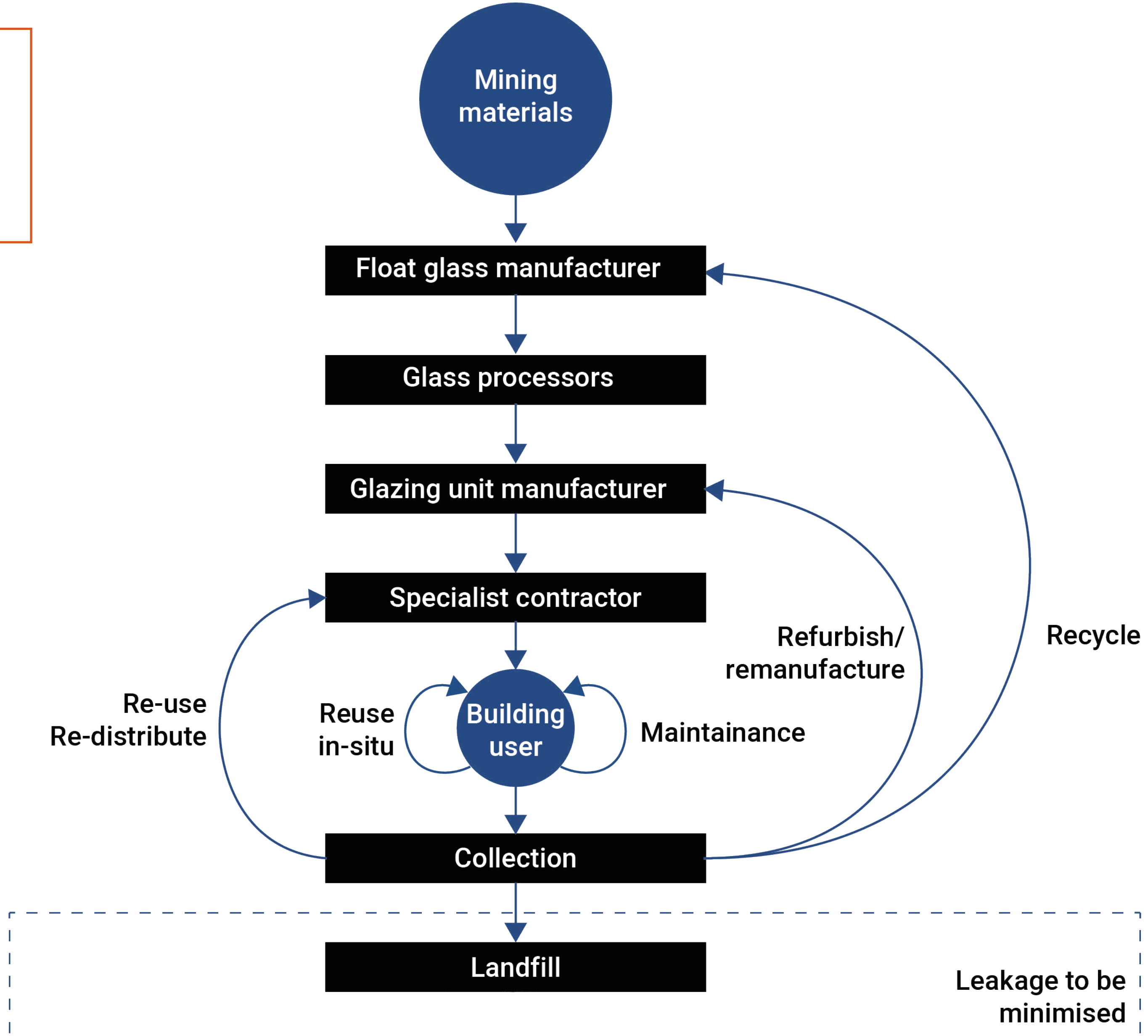
Improved manufacturing yield in addition to the reutilisation of end-of-life flat glass as cullet in new production could reduce the annual emissions of the UK flat glass value-chain by up to 18.6% (7).

(5) Re-thinking the life-cycle of architectural glass – Arup (2018)
(6) How reusing and recycling glass can cut a building's carbon emissions - Graham Coult and Stephany Le Rhun - RIBA Journal (2024)
(7) Mapping the flat glass value-chain (2022)

(see Further Reading for full references)

2: UK GLASS - CURRENT SITUATION

Re-thinking the life-cycle of architectural glass. Diagram adapted from UKGBC Building glass into the circular economy - How to guide (2018)



3: GLASS PARTITIONING SYSTEMS

The UK suspended ceilings and partitioning systems market is showing signs of recovery after experiencing significant challenges in recent years. Valued at an estimated £283 million in 2020, the market declined by around 16% due to the impact of the COVID-19 pandemic. However, prospects for the future are relatively optimistic, with forecasts suggesting growth to approximately £335 million by 2025. Partitioning systems are led by static demountable and relocatable products, which constitute 57% of this segment. (Suspended Ceilings and Partitioning Systems Market Report – UK 2024-2028, AMA Research).

Glass partitioning systems can be designed and installed as fixed (permanent), demountable or relocatable systems. The vast majority of systems can be removed intact from their installed position - though with varying levels of complexity and potential damage to surrounding materials.

Permanent or fixed partitions span between the floor and ceiling slabs and are often fixed into a studwork wall. To remove a fixed partition, you would need to remove part of the ceiling and floor.

Demountable partition systems are a non-permanent partition which can, if necessary, be taken down with minimal damage to the main fabric of the building fit out (often called CAT-A elements), such as raised floors and suspended ceilings, but removal may damage the partitioning system. See drawings for Optima's Adaptable Wall as an example (page 9). Note that Head track and Base track is the same for double or single or solid panel, with a simple non-destructive removable clip plate. Systems can be interchanged in-situ and easily removed for relocation /reuse.

Relocatability is different from demountability. All proprietary glass partitioning systems are demountable to some degree, but they are not necessarily fully relocatable.

Relocatable partitions should be capable of being taken down and reused within the same building or elsewhere. Relocatable partitions offer flexibility by allowing the rearrangement of office spaces regularly and repeatedly, and are therefore designed to be easily disassembled and reassembled multiple times.

3: GLASS PARTITIONING SYSTEMS

SKA (SKA rating is an environmental assessment method, benchmark and standard for non-domestic fit outs) define relocatable systems as:

- A relocatable or reusable modular partition system that can be removed and relocated without substantial repair (using a minimum of 80% of the original components); it should be capable of reinstallation within a tolerance of ± 10mm of the original installed height.
- Note: demountable partitions cannot be taken down without damaging or destroying some or all of the components.

Partitions are typically fixed to a suspended ceiling or a soffit, as these are not standard dimensions reuse may be limited in the donor building. Tolerances of ± 15-20mm can be provided using deep head sections. Whilst it is not worth the complexity of cutting larger panes of glass that are too tall for a proposed space, it can be possible to reuse panels that are shorter than the floor-to-ceiling height by building a bulkhead drywall.

Relocatable systems are generally bi-block (two steel panels installed on both sides of the steel frame, leaving a void in between) or monoblock (double skin partitioning, with less system materials) products which exclude plasterboard-based systems and could be steel, laminated boards and glass.

3: GLASS PARTITIONING SYSTEMS

Glass to glass dry joints aid demountability, but in order to be classified as relocatable, the glass partition should also be capable of accommodating a tolerance of ± 10mm of the original installed height upon relocation, and should be able to be taken down and reused without substantial damage to both the main building fabric and the partition itself.

Relocatable partitions can offer tax savings because they qualify as Plant and Machinery under the Capital Allowances Act 2001. This means businesses could claim capital allowances against tax, though this needs to be checked on a case by case basis.

The performance of a glass partitioning system is dependent on its laboratory test reports where estimates can be made based on the type (toughened, laminate) and thickness of the partition. Tests can include airborne sound insulation, fire resistance in minutes and reaction to fire classification and robustness. The original manufacturer should be able to provide this information. Unfortunately, it is often unclear who this is from just looking at the panels.

Documentation should be looked for in the O&Ms, but this will not always specify the manufacturer. Performance will also be dependent on where the partition is reinstalled, the integrity of the perimeter (surrounding materials) and the quality of the installation. Sound insulation of a glass partition can be enhanced if an acoustic barrier is built under the raised access floor, and above the suspended ceiling. Not all partitions are fire resistant or need to be.

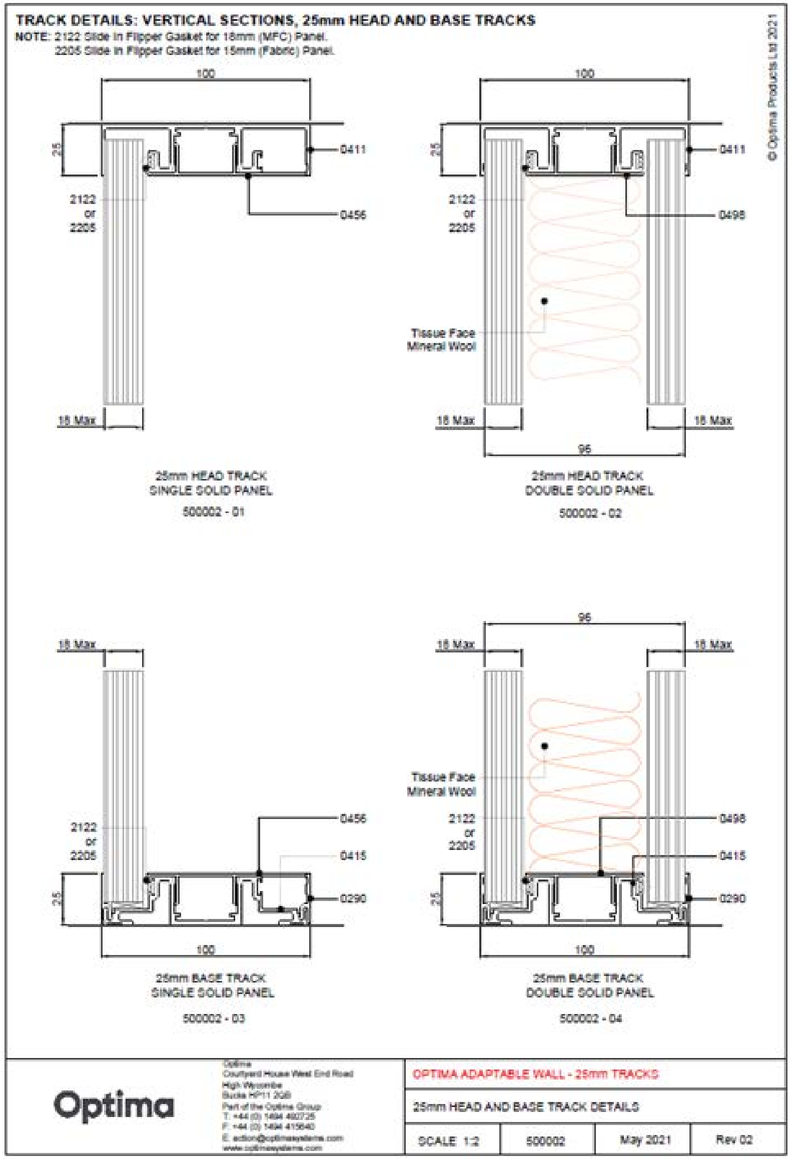


Image credit: Optima

4: WHAT DOES A GLASS PARTITIONING SYSTEM COMPRISE?

Heat Strengthened Glass is semi tempered or semi toughened glass. The heat strengthening process increases the mechanical and thermal strength of annealed glass, making it twice as tough as annealed (or float) glass. When it breaks the fragments tend to be larger in size than broken annealed glass, and with a greater likelihood of staying together. It is used in applications where a higher level of thermal resistance is required but the full strength of tempered glass is not necessary such as in some architectural glazing facades, and skylights.

Toughened Glass also known as safety glass, most widely used glass in the construction industry particularly for partitioning systems. If broken it breaks into chunks of glass, not shards. Tempered glass undergoes a similar process, but it is further enhanced through chemical treatment. Toughened glass can be identified by the BS Kite Mark typically printed in the corners of the glass. Standard: BS EN 12150.

Laminated Glass is made by bonding two layers of annealed glass either side of a PolyVinyl Butyral (PVB) Interlayer. To be categorised as Class A safety glass, the PVB interlayer must be not less than 0.76mm thick and achieve safe breakage by the interlayer holding the fractured panel together. Standard: BS EN ISO 12543

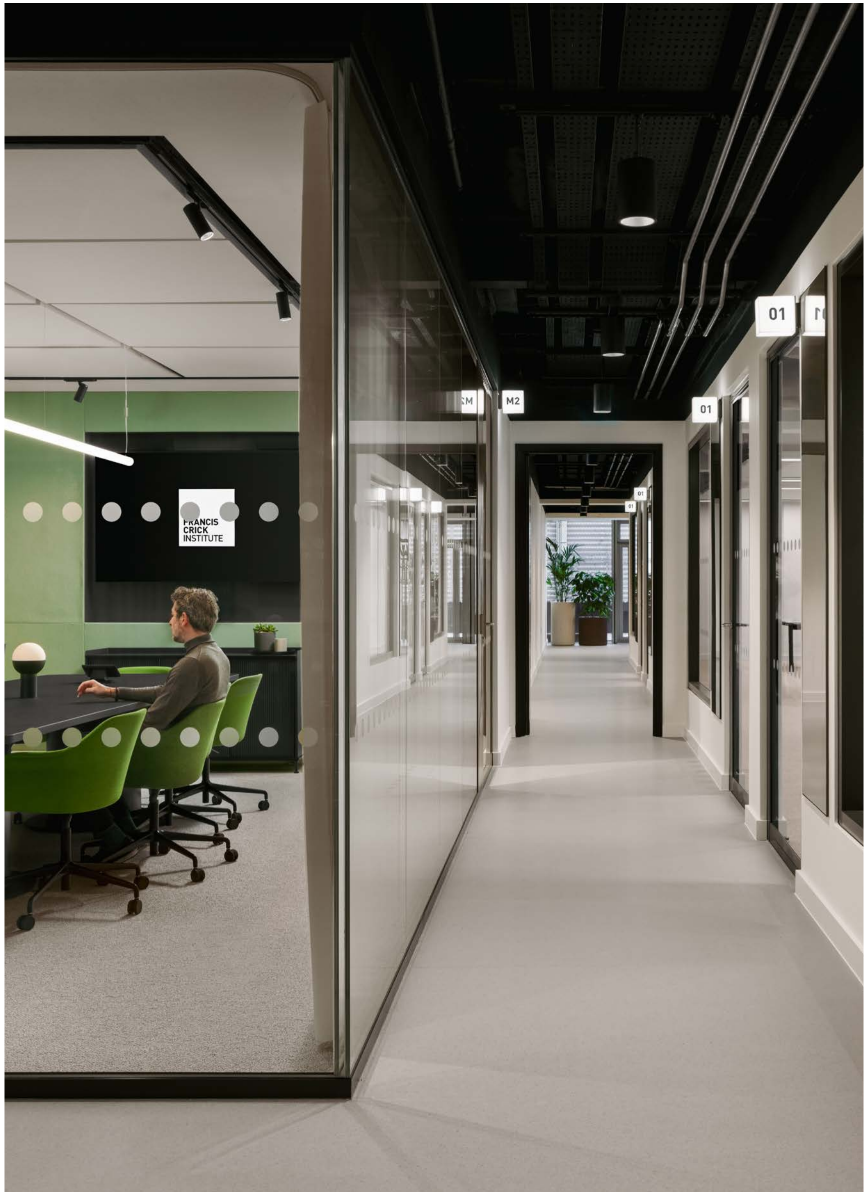


Image credit: Optima. Demountable system with bulkhead

4: WHAT DOES A GLASS PARTITIONING SYSTEM COMPRISE?

Acoustic Laminated Glass is a laminated glass panel often made up of two sheets (or more) of glass bonded together with a specially formulated PVB interlayer designed to achieve significantly better acoustic properties; can be used in both single and double glazed systems. BS EN ISO 12543

Fire-Rated Glass helps prevent fire and smoke from spreading from one area to another. It is estimated that toughened glass can usually withstand 260°C, while fire-rated glass can withstand an excess of 870°C. Fire rated glass is typically marked with the brand name, the standard (e.g. BS EN14449), and the impact rating (e.g. 2B2)

Single Glazed Walls - formed of one layer of glass, usually toughened or laminated glass (or panels that have been both toughened and laminated) that is sited in a U-channel track or aluminium profiles.

Double Glazed Walls - formed of two layers of glass offering significantly improved performance in comparison with single glazed options. Having two layers of glass can create an insulating layer in the middle – either a narrow space between the panels that can be filled by a gas or vacuum or provided by another layer of transparent material, helping to retain heat and absorb sound.

Frameless Glass Partition Walls - glass panels in a frameless glass partition system joined using either a wet joint (silicone) or dry joint (prefabricated rubber jointing tape or strips) method. Dry joints are uniform and easier to fit but offer little or no flexibility in the size of gap between each panel. Silicone joints are more flexible and tend to offer better acoustic insulation but can be messy and time consuming both to apply and also to remove for future use; can be used for both single and double-glazed options.

Framed Glass Partition Walls help strengthen glass wall rigidity due to panels being framed with an aluminium profile, used on single and double glazed projects.

Frameless Glass Doors - frameless single glazed glass doors are common where acoustics and privacy are not an issue.

Framed Glass Doors offer better rigidity and acoustic performance than frameless doors, can be single or double glazed.

4: WHAT DOES A GLASS PARTITIONING SYSTEM COMPRISE?

Product facts

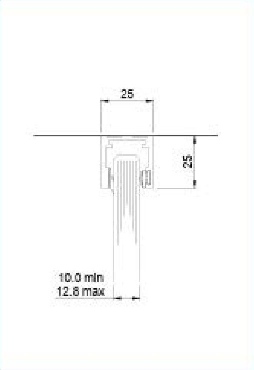
- Minimal single glazed system
- Dry jointed and fully demountable
- Aluminium framework
- Fully integrates with Revolution 54 and Revolution 100 systems
- Numerous door options
- Manufactured at Optima's UK factory in Bath

Acoustics

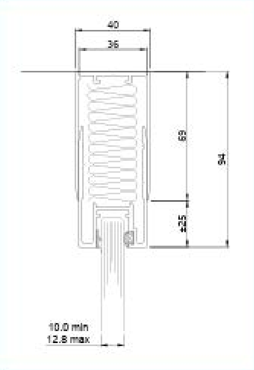
- Maximum tested acoustic rating of Rw38dB using 12.8mm acoustic laminated glass and Rw40dB using 16.8mm acoustic laminated glass

Deflection

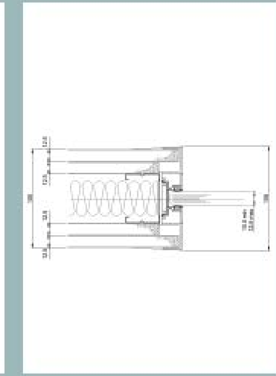
- Can accommodate up to ±40mm deflection



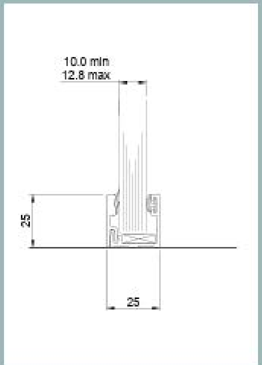
Single glazed head track 25mm x 25mm



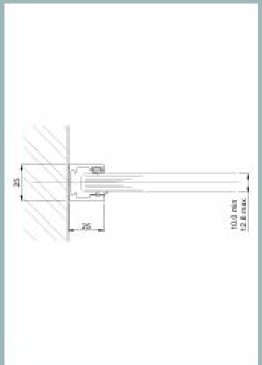
Single glazed head track with outer upper channel ±25mm deflection



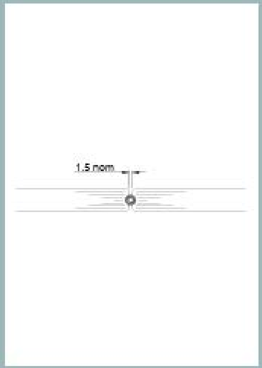
Tapeable glazing bar single glazed, double boarded



Single glazed floor track 25mm x 25mm with clip-in bead



Single glazed 25mm x 25mm wall abutment



Glass to glass Nebula® patented dry joint 12.8mm & 16.8mm glass

Example of single glazed system with minimal head and base channels and discreet glass to glass dry joints

Product facts

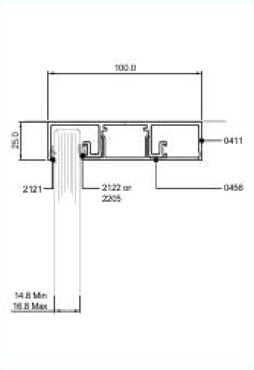
- High acoustic mullion-free glazed partition system
- Can be single or double glazed
- Dry jointed and fully demountable
- Aluminium framework
- Numerous door options including 100mm thick Elite Series
- Manufactured at Optima's UK factory in Bath

Acoustics

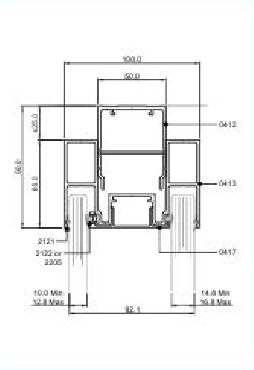
- Maximum tested acoustic rating of Rw53dB double glazed using 2 x 16.8mm acoustic laminated glass and Rw40dB single glazed using 16.8mm acoustic laminated glass

Deflection

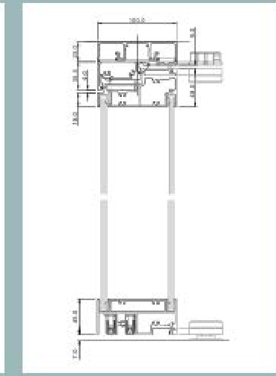
- Can accommodate up to ±40mm deflection



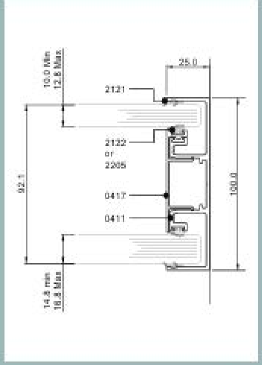
25mm head track single glazed



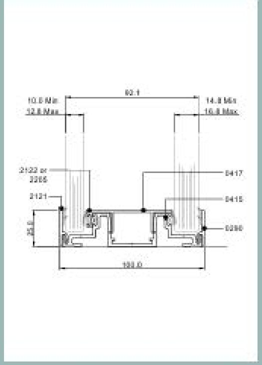
Head track with inner upper channel ±25mm deflection double glazed



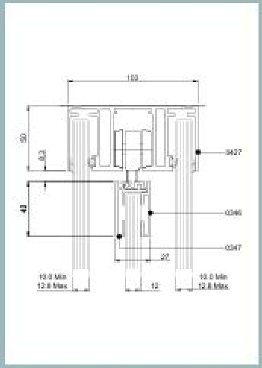
Vertical section D660 door frame and Elite Symmetry 100mm door with pull handles



25mm abutment double glazed



25mm floor track double glazed



Elite Aero Sliding Door with 50mm head track

Example of a dry jointed system which can be single or double glazed

4: WHAT DOES A GLASS PARTITIONING SYSTEM COMPRISE?

Example of a double glazed system with a slimline aluminium framework which is bonded to the glass, thereby retaining both the structural stability and acoustic performance of the glass partition.

Product facts

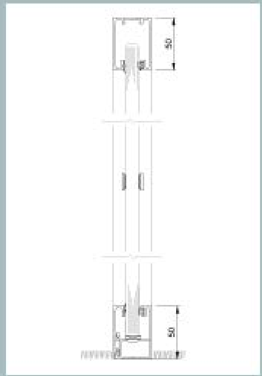
- Shoreditch aluminium glazing bars can be applied to single or double glazed Shoreditch Edition screens
- Single glazed version - Optima 117 Plus Shoreditch Edition
- Double glazed version - Revolution 54 Plus Shoreditch Edition
- Dry jointed and fully demountable
- Door options - Single glazed or double glazed Edge pivoting glass door, or Kinetic Align sliding glass door with Kinetic Shoreditch Edition only
- Manufactured at Optima's UK factory in Bath

Acoustics

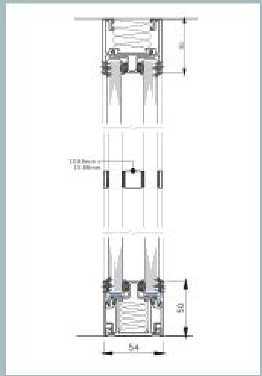
- Rw38dB for Optima 117 Plus - Shoreditch Edition, using 12.8mm acoustic laminated glass
- Rw48dB for Revolution 54 Plus - Shoreditch Edition, using 2 x 12.8mm acoustic laminated glass

Deflection

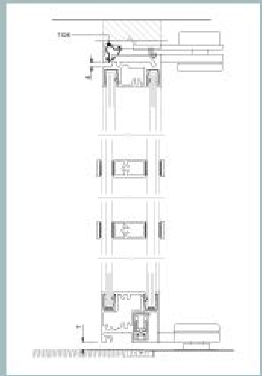
- Can accommodate up to ±40mm deflection (±25mm for Kinetic Align)



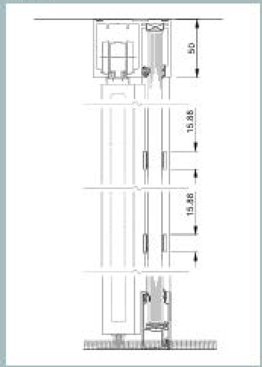
Vertical section through Optima 117 Plus single glazed Shoreditch screen



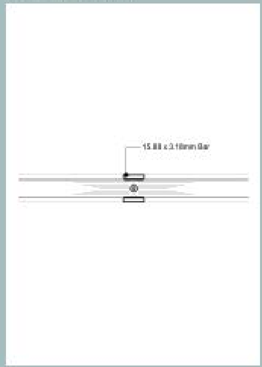
Vertical section through Revolution 54 Plus double glazed Shoreditch screen



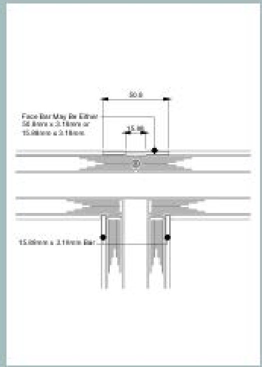
Vertical section showing double glazed Edge Symmetry door



Vertical section showing single glazed Kinetic Shoreditch glazing and Kinetic Align door



Vertical section through single glazed butt jointed glass



Vertical section through double glazed butt jointed glass

5: WHAT COULD/SHOULD BE DONE TO ENCOURAGE MORE REUSE

…and if that is not possible then at least ensure it is 'closed-loop' recycled to retain more value than recycling/downcycling.

How can we increase the supply and demand and therefore create a bigger market for reused partitioning systems and high quality cullet? Reclamation and reuse and/or closed-loop recycling rates need to be supported/ encouraged and could be legislated through the following policy/legislation and process recommendations and suggestions:

Image credit: Optima. Demountable system with bulkhead

Policy/legislation

Increasing the landfill tax would result in giving financial incentive to contractors, and consequently clients, to divert glass waste from landfill and ideally return it for closed-loop recycling. Removing glass from the Landfill Tax legislation of "qualifying materials list" may encourage further glass recycling, though it may still end up being downcycled for aggregate.

Mandatory carbon reporting/ legislating embodied carbon targets - requiring construction product manufacturers to disclose the embodied carbon content of their products, enabling consumers and businesses to make informed choices based on environmental impact.

- Glass is very high in embodied carbon. Lower carbon glass with a higher amount of recycled content is feasible and currently being manufactured, however until the market values lower carbon glass more, it will not be manufactured at scale. Insufficient demand for lower carbon glass is part of a 'vicious circle' where the amount manufacturers are willing pay for cullet is not enough to encourage the wider supply chain to provide uncontaminated cullet back to the manufacturers for the closed-loop recycling of flat glass. Generally projects providing cullet for closed-loop recycling are being led by forward thinking developers with strong KPIs around circular economy solutions and lowering their carbon emissions.

- Introduce regulations and standards for embodied carbon in construction products and incentivising the use of low-carbon materials through tax credits or subsidies.

5: WHAT COULD/SHOULD BE DONE TO ENCOURAGE MORE REUSE

Defining standard clauses that can be included in contractual documents would assist the industry to adopt requirements for reusing and recycling building materials. Tender responses could require the contractors to state the amount of reclaimed glass as well as the % of recycled glass content being purchased from their supply chain and encourage the measurement of what is being returned to the supply chain from refurbishment and demolition projects. This could potentially have a positive effect on the promotion of increasing recycled content by the glass manufacturers, as they currently do not openly advertise this information.

Improved collections/ separate collection systems – could local authorities facilitate collection and transport of cullet? Alternatively, the private sector could work together to deliver a more effective scheme. Vlakglas is a non-profit in the Netherlands financed by a mandatory recycling fee; and individual resource management glass specialists examples are Eurovetro in Italy and Saint Gobain's Glass Forever programme, as well as Pilkingtons renew:glass in the UK.

Supporting reuse and recycling targets for flat glass by embedding requirements into planning and having requirements around reclaimed and recycled flat glass in public procurement.

Implementing Extended Producer Responsibility in construction products, including glass. For example manufacturers of highly recyclable materials, like glass, should be obligated to take back and recycle their own material, forcing them into dealing with their waste and pushing them to review the materials ingredients both to make their materials 100% recyclable – and also that they are recycled.

Eco-labelling programs - establishing eco-labelling schemes to certify construction products with low embodied carbon, providing transparency and recognition for environmentally friendly materials. EPD could be part of this.

Tax incentives - introducing tax incentives or credits for construction firms that adopt innovative and sustainable building techniques; and – for example - for companies who demonstrate a minimum of 20% saving on embodied carbon in interior fit out schemes. There should be a VAT incentive, especially considering the current VAT construction issue, where refurbishments are penalised while new buildings receive a 20% reduction.

Increasing the price of virgin cullet vs recycled cullet using Climate Change Levy, carbon tax and tax exemptions or capital allowances.

- Currently the low market price for cullet pushes recyclers to sell glass as part of combined waste for aggregate instead.
- Market place price for virgin materials to make flat glass is on average cheaper than cullet due to cost of deglazing, segregation, storage and transportation.

Research and development funding - allocating resources for research and development in construction materials, techniques, and interior fit-out solutions to drive innovation in the industry.

Certification schemes like BREEAM and SKA should include a credit requiring that at least X% of site glass be sent to recycling facilities where it is recycled back into the same quality products, rather than being downcycled. This could also encourage take back schemes.

5: WHAT COULD/SHOULD BE DONE TO ENCOURAGE MORE REUSE

Processes

Commercial sensitivities of building product manufacturers may require some overcoming as glass manufacturers can be protective of their processes to maintain competitive edge. Legislation may be required to make the release of (some of) this information compulsory for clarity on recycled content of products.

Screen-printing and digital printing utilises ceramic frits applied to the glass for architectural, shading or privacy requirements. These ceramic patterns are fused into the composition of the glass following application using heat-treating techniques. The presence of ceramic frit does not currently allow the glass to be returned to remelting through the recycling loop. Given the safety requirements to have markings on glass panels the ideal choice for this is vinyl applications that can be removed to allow for a different choice of marking or to facilitate recycling.

Regarding the significant amount of waste at Cat B stage - could internal partitions be outside of Cat B in terms of dilapidations? Landlords should discuss with tenants that are vacating, what they plan to do with their glazing partitions. If the partitions remain in the building, the floor-to-ceiling height is likely to stay the same or be very similar, which significantly increases the chances of the glass panels being reused. They should not be removed until the new tenant is secured and has confirmed they are not required.

Materials passports and pre-demolition audits What information is most useful? Ideally this needs to be standardised. Enable better tracking/tagging and materials passport type information eg QR codes, RFID tagging. Better asset tracking and early pre-demolition audits would enable higher levels of reuse both due to having better knowledge about the product (spec, age, manufacturer…) and also having more time to find in-situ solutions or interested recipients.

Surplus materials - as with every aspect of the construction supply chain there is always surplus (due to cancellations/ clients changing their mind) which the industry needs to ensure is (re)used as a minimum – above and beyond even reclaiming after first use!

Time/ effort/ money to dismantle - need to compare like for like when cost reporting and researching options. It seems rare to cost in that the systems have to be broken down before they can be effectively recycled. If we are costing every single process for reuse then we need to be costing every single process - including disposal - for first time use. Also can reinforce with the client that in the process of reuse this budget is being invested in labour/ skills whereas when purchasing new their funds are being spent on the extraction of virgin materials with the associated negative environmental impacts.

5: WHAT COULD/SHOULD BE DONE TO ENCOURAGE MORE REUSE

Improve reverse engineering/ reverse logistics processes - Manufacturers that do take back for reuse struggle when there is 'no owner', they generally don't have the storage or the procedures in place to handle the reverse process. When a client says "here's an existing partitioning system, can you deconstruct it, take it away, service it and adapt it to suit our needs and then reinstall and rewarranty the system" – then some manufacturers such as Optima will do that for their own systems. They know the system, feel able to rewarranty it and can justify the effort because there is a client that wants it. Manufacturers are less comfortable doing take-back outside of this scenario.

FIS Pre-Cycle Agreement - The Finishes and Interiors Sector (FIS) has developed a pre-cycle agreement that provides a structure for manufacturers to provide closed-loop recycling or reuse take back schemes that is verified by a 3rd party. The PreCycle agreement brings both the manufacturer and user of the product together from the beginning of the project to ensure that during construction and at end of use, the material can be recovered, repurposed, recycled or processed in the most environmentally sustainable way by keeping the product at its highest value application and importantly avoiding landfill.

Raw materials issues - Manufacturers to promote awareness around increasing pressure on raw materials – for example establishing a sustainable sourcing standard and training programmes.

Designing for circularity - using the most environmentally sustainable materials in the first instance, and guaranteeing that partitioning systems (doors, frames and glass panes) are designed for disassembly and reuse and are 100% recyclable.

Better value chain integration - including online flat glass marketplace, measuring flat glass recycling performance, building capabilities amongst those already involved, designing for reuse and recyclability.

Data and knowledge - There is not a lot of data regarding reuse of glass or recycling of flat glass, both due to lack of infrastructure and regulation; this coupled with a lack of awareness, knowledge and training & skills is stymying the adoption and advancement of the reuse of glass/ glass partitioning and closed-loop recycling.

6: QUESTIONS TO ASK AT AN EARLY STAGE

When there is an existing building:

Can the partitioning be easily demounted and relocated?

Is there any manufacturer literature or installation and maintenance history available (eg in the O&M manual?)

What is the key information to capture should deconstruction be an option? A detailed inventory of the glass should be compiled from the key information - leading into material passports for each individual panel, ideally the system would have a materials passport but as components can get separated, they will also each need their own passport. This should include:

- Dimensions: height is particularly important, weight (not least because panels that are too large an area or too heavy are very cumbersome)
- Type of glass: for example use the tap test - tap the glass gently, laminated glass will produce a dull thud or thump, while tempered or annealed glass will sound more like a ringing or ting.
- Type of partition
- Manifestations: for example fritting, etching, or window film.
- Damage: any chips, scratches, or other condition-related aspects
- What method of fixing has been used
- And additionally when and where the glass was sourced from, where it then went, who took it, where it was stored, who moved it, who resold it, etc.

Logistics should be considered at an early stage as this may dictate what parts, if any, can be moved from site 'whole'. Questions include what floor are the partitions on? Is there a goods lift? Do they fit in the goods lift? If not, what is the access to/from site?

To achieve successful reuse and derisk the process as much as possible, it is key for design teams to become familiar with demolition practices or seek advice from a deconstruction specialist to iron out practicalities and logistics at an early stage.

Image credit: Optima. Optima systems are designed with reuse in mind.

6: QUESTIONS TO ASK AT AN EARLY STAGE

Can the partitioning be reused in-situ?

- **YES**: Does it match the existing designs for an onsite project (best solution but rarely the case); if not, can the client and design team for the new scheme adjust their designs/ requirements?

- **YES**: If it can be reused in-situ, there are a number of further questions for the client to consider such as:

    - Does it need to be stored elsewhere on site and protected during works?
    - Do you need specialist contractorsto take down and reassemble or does your team have the expertise?
    - Can it be stored on the same floor and not have to move up/down stairs?
    - Does it need any retesting/ certification?
    - Does it need remediation/ upgrading?

- **NO**: Is it technically feasible and financially viable to remove the partitioning from the existing building?
    - If on an upper floor, is there a goods lift large and accessible enough for efficient and safe removal of the panels?
    - Would other walls, partitions or fixtures need to be removed to make way for the glass to be handled out of the building?
    - Does the route out of the building allow for temporary storage of the partitions whilst awaiting collection?
    - Is there a loading bay / collection point large enough for a suitably-sized vehicle?
    - Does the loading bay allow for a vehicle to be parked for at least half an hour whilst being loaded?

- **NO**: If in-situ reuse is not possible can an offsite recipient be found before the partitioning is taken down? Finding a recipient before the items get disassembled/deconstructed, if at all possible, gives more incentive for reuse (also to minimize and justify any storage costs), and an ownership and logistics ‘plan/ pathway’. This is particularly important given glass has a ‘shelf life’ but also that if in storage for too long it skews the cost of reuse further.

6: QUESTIONS TO ASK AT AN EARLY STAGE

Is the prospective user of the reused partitioning willing to take on some risk (due to probable lack of warranty)?

Is it possible to retain glass in-situ until collection to new site is organised? If not, is there storage at the donor or receiver site available during the interim period? If not and alternative storage is required, is suitable storage available at a price point that is financially viable?

If reuse is not feasible but the partitioning can be taken down and out of the building, is a third-party reuse organisation willing to collect the partitioning for resale or donation?

If reuse of the whole system is not possible then can at least the door(s) be salvaged for reuse – as the highest value part of the system and also easiest component to take out for moving – and the rest of the partitioning be broken down for closed-loop recycling?

If reuse is not feasible then is there a manufacturer take back scheme? Criteria for take back must be clearly set out.

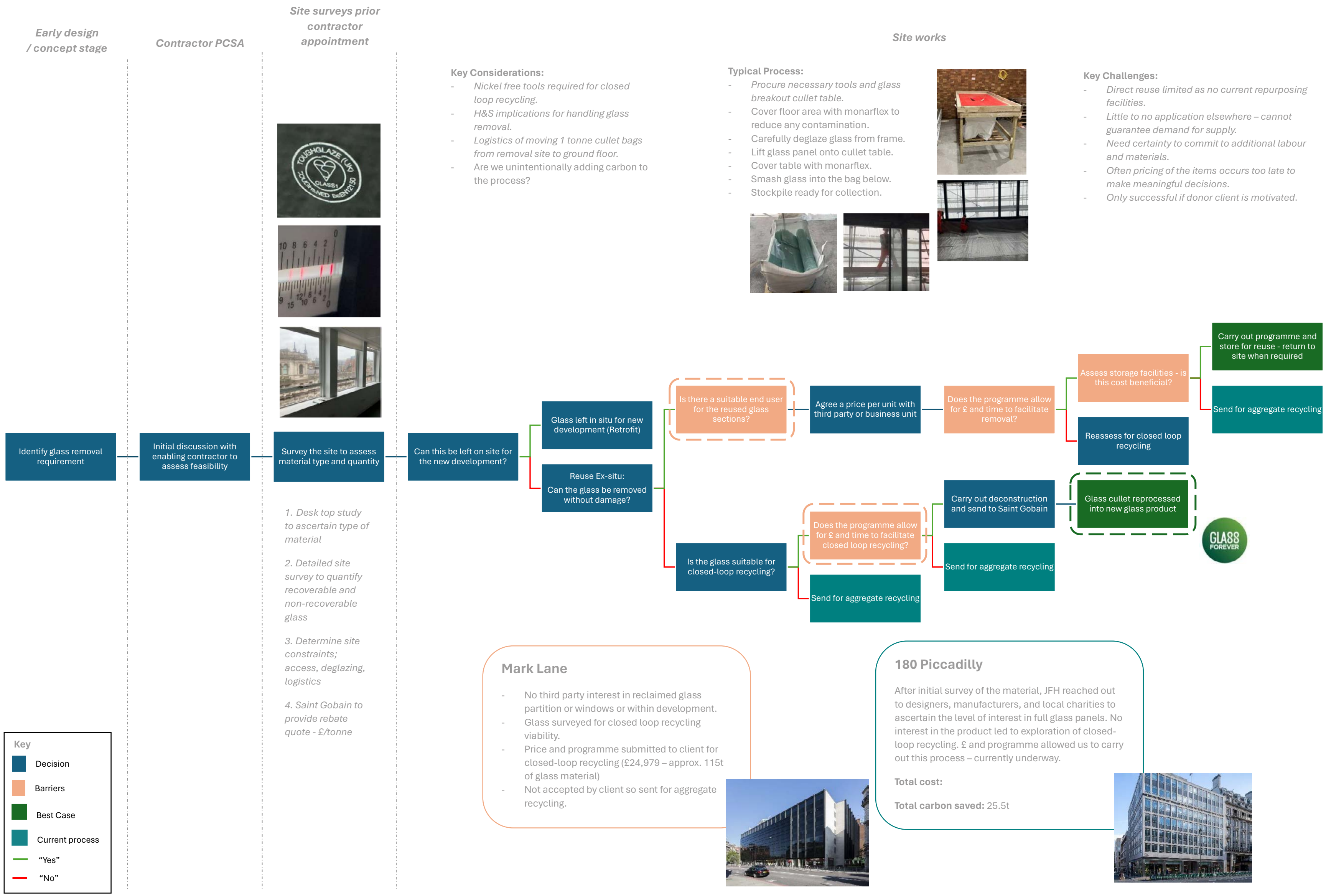
If reuse or take back is not an option then can the components go to a recycling facility that would closed-loop recycle it into new glass panels.

Last resort is downcycling the glass to be part of a crushed aggregate.

NB. A new frame system can be designed to be used with glass from an existing project but if the glass needs to be cut then it's not worth doing in terms of cost or carbon. Floor tracks are really hard to salvage, but side mullions have potential for reuse. The framing is quite a small cost in relative terms.

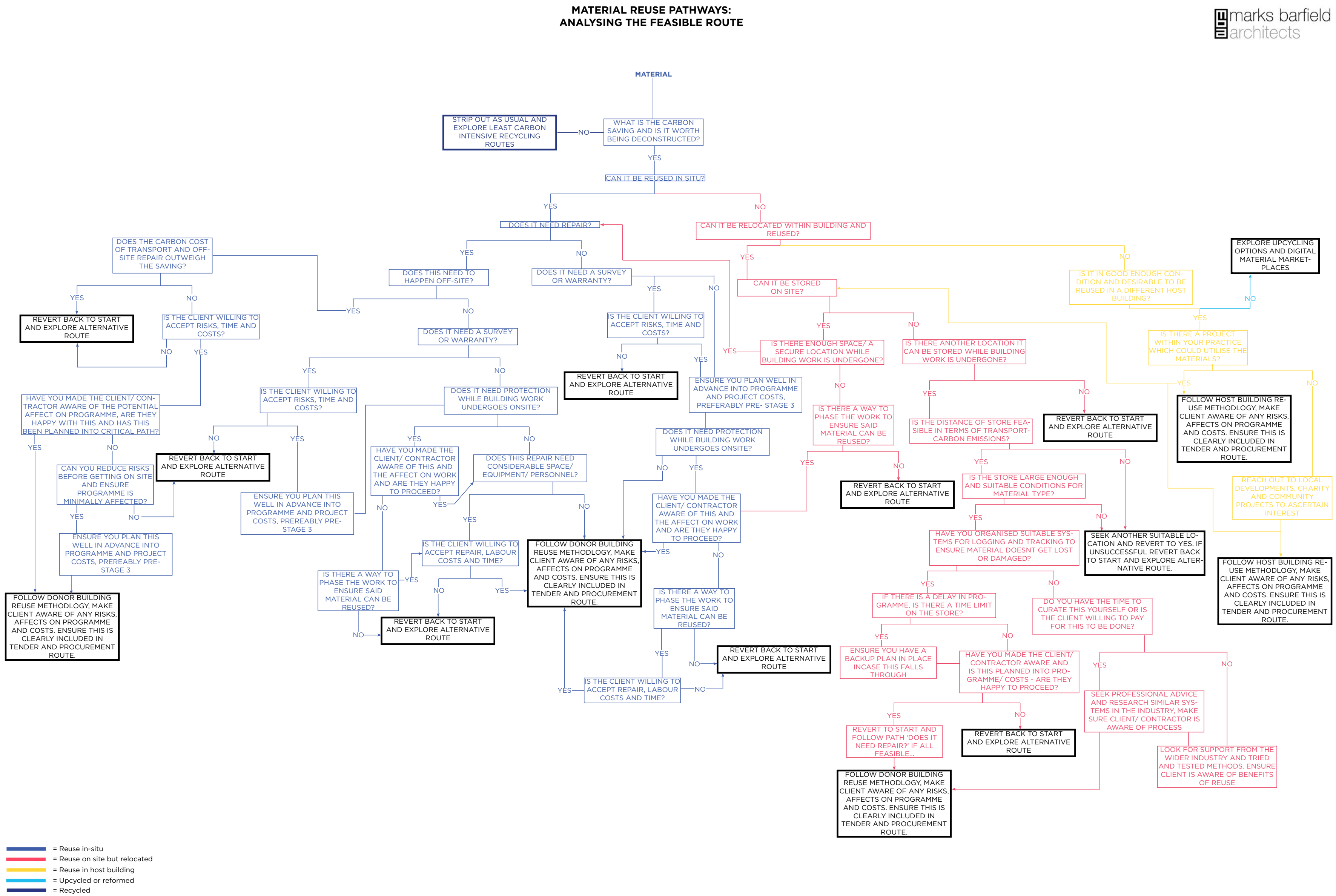
Also where new framework is to be provided, make sure to consult with the original manufacturer of the system to ensure whether a new framework system can be provided that will maintain the performance characteristics or the original system/installation.

6: QUESTIONS TO ASK AT AN EARLY STAGE



Example of the decision-making process in action – John F Hunt (click here for larger version of the graphic)

6: QUESTIONS TO ASK AT AN EARLY STAGE



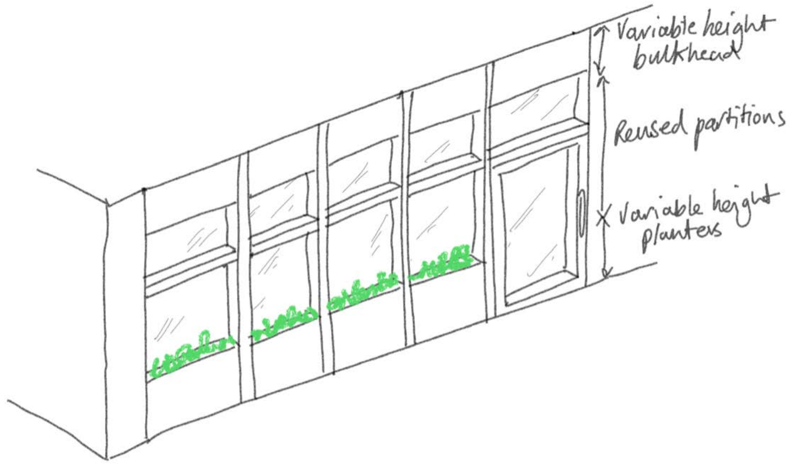
Example of the decision-making process in action – Marks Barfield (click here for larger version of the graphic)

7: DESIGN GUIDANCE

Glass products need to be designed with end of life in mind (e.g. insulation, ceramic inks, lamination…) and systems/ units should be designed for easy disassembly, reuse and reinstallation.

Unless reuse is to be explored within the owner/developer's own development or portfolio, the market demand for reused partitions is low and this affects the willingness of clients to pay for the risk of removing them 'whole' over breaking up for cullet recycling. However most internal/in-situ applications seem to be of similar size and quality across offices so this should not be a blocker for reuse. Could it be that architects aren't yet confident in the supply/quality of the partitions so they are reluctant to specify?

If the designer has early knowledge of and information about the reclaimed partitions, they can often design around what is available. All floor-to-ceiling heights don't necessarily need to be standardised, but if the available materials can be presented early enough, designers can incorporate them.



Designing for flexibility & adaptability: should designs be a more standard size moving forward?

Can we design more buildings with a common floor to ceiling height, and partitioning layouts with common sizing to facilitate reuse? The variability of floor to ceiling heights is a big issue for reuse, we have a mixed existing building stock and therefore heights vary but we should be looking to have a more standardised grid in new builds.

As retrofit and reuse of structure becomes more of the norm, could partitions be designed which have a standard datum (2400mm) and work with re-adjustable base and head details? If designing the system so that the bottom section of the partition is reusable (for example 2100mm), when floor to ceiling is different from donor to receiver, it is only the top part of the system that needs to be replaced – reducing waste by around 85%. Also need to ensure doors are standard heights for reuse.

Standardisation benefits the onward/second user not the first user – it's an ethical/sustainable choice to request more standardised systems as it doesn't benefit the first user.

Glass frames should be designed to accommodate different glass thicknesses and allow for different heights.

Clients should be encouraged to accept standard module widths with a make-up panel, rather than equally divided panels so that runs or partitioning can be more easily reused replacing make-up panels only.

7: DESIGN GUIDANCE

Doing more with less

When fitting out a new building - are there any components such as a partition wall or glass panels available on a different site within the client's portfolio or a materials reuse platform that could be used, instead of ordering new?

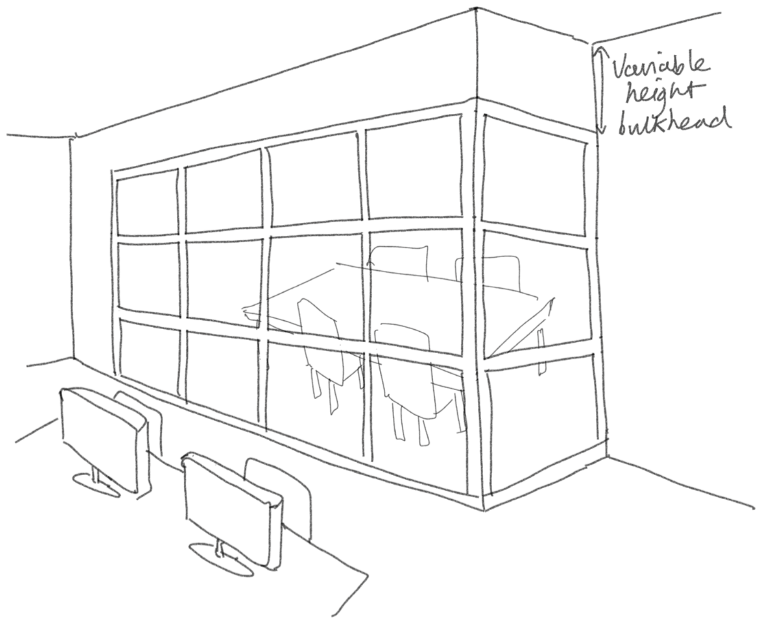
Doors are designed/warrantied for much longer that their average life span – for example an Optima door is designed for a 25 year life - but the average life span of a partitioning system door is 5.2 years due to refurbishments. Should systems be designed to last for 10 years not 25? Ignoring this issue and continuing to overengineer for the average life span means reuse is even more vital to ensure the capital and carbon investment is protected and maximised.

Could architects design with less glass and smaller modules for less risk regarding H&S and ease of dismantling? Have partitions start at 800m high with a planter at the bottom so it's more easily adaptable, with flexible head and base details or standard bulkhead which could be changed.

If framing (often metal) is too thin/ delicate it can get warped in the deconstruction process. Consider deconstruction of each 'piece of the puzzle' at an early stage.

General note from demolition contractors is not to overcomplicate details – if each material component can be accessed easily by the deconstruction contractors, there is likely a way to deconstruct. For example architects should consider joints and details, and also think about the specification of manifestations/ design details which cannot be easily reversed for the next user.

A key element to consider for the redesign/ reassembly of partition is the replacements of gaskets. If these are done to a sufficient level, the acoustic performance can likely be maintained.



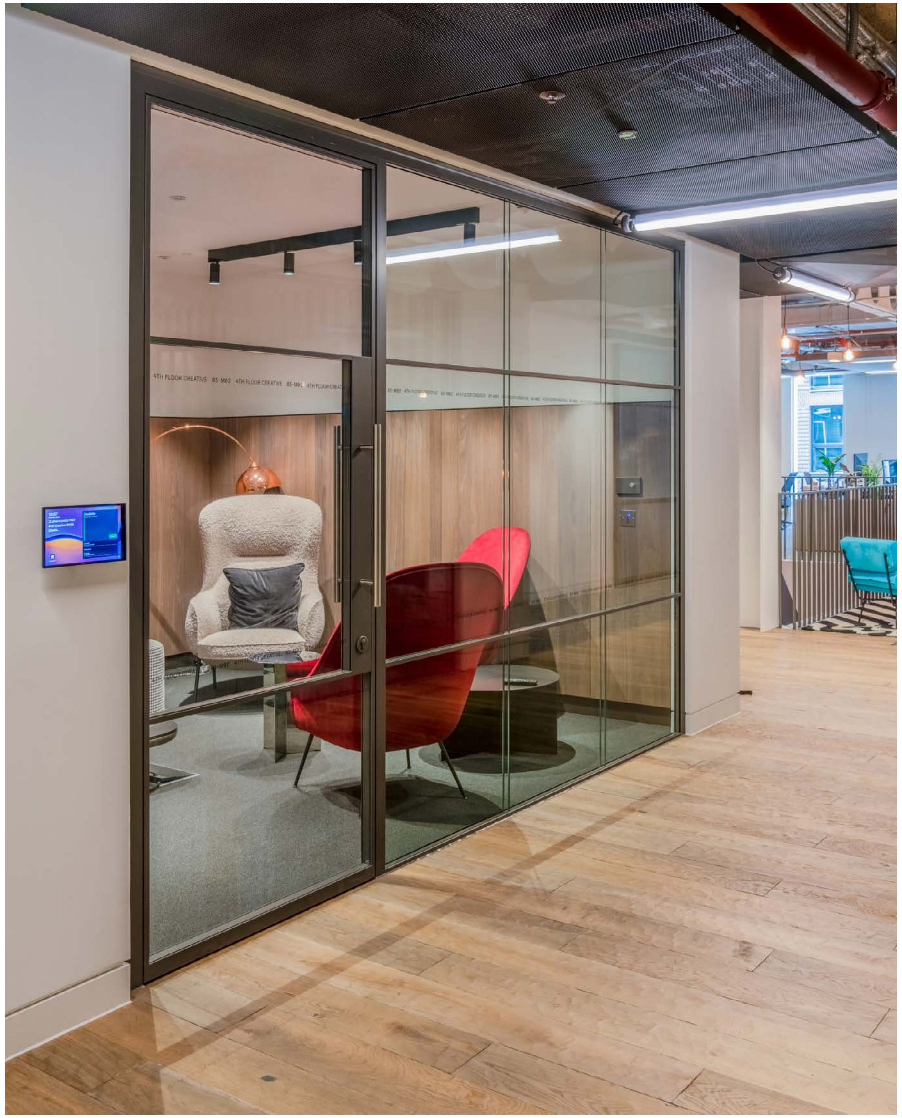


Image credit: Optima. Demountable system

Demountable & relocatable vs permanent systems

Demountable and particularly relocatable systems can be upgraded or moved (relatively) easily, are simple to install and uninstall as required and, as with permanent systems, include single or double glazed windows, and options for frame finishes, wall coverings, vision panels, skirting and doors.

The main difference is how the partitions are fitted to the floor, ceiling and walls, and what materials they are framed with. (for more details see section 3)

Demountable and particularly relocatable systems could help save money as they can be taken with the owner and reused at the next location. Additionally the potential tax savings that relocatable systems offer means they can be a good choice for businesses wanting flexibility.

There are often initial discussions about designing / creating demountable products but rarely is full consideration given to the team who will end up carrying out this work in 5-15 years' time. Aspects such as information on how and who to send the items to for remanufacture should be covered in materials passports but a standard format has yet to be decided on, nor where the information is to be stored or who takes responsibility for it. Also the teams likely to be working on site for any future deconstruction may not be well versed in technology so access to the information must not be overcomplicated. If the information is not readily available it is likely to revert back to business as usual.

8: DECONSTRUCTION GUIDANCE

Undertake a pre-refurbishment/pre-demolition audit to estimate the materials that can be reclaimed for reuse – for example types of glass (eg laminated), single/double glazed, whether it has manifestations on it.

Typically a specialist contractor will be required to carry out the deconstruction.

Clearly indicate (ideally on the demolition drawing as well labelling the item) what glazing is being retained, what is being removed from site to be reused or closed-loop recycled, and what is being removed to be downcycled.

If take-back of some elements is difficult, is there scope for partial takeback? Tackling one element at a time? Reuse (or closed-loop recycling) of glass but takeback of framing and accessories such as ironmongery, or just take back of the doors?

Ensure a robust Risk Assessment and Method Statement is in place, which will include Health and Safety considerations such as additional PPE required – eg Kevlar sleeves. What processes have to be put in place? Specific to handling glass?

Carefully dismantle the glazing track, the removal of the glazed door (particularly heavy) and the glazed panels.

Number each item as it is being removed and where possible record this on the site demolition drawing.

The glass partitions should be taken down in a dust free environment as otherwise there is a risk of contaminating the system.

Doors can be taken off in as little as half an hour, with very little noise, no skilled trades, it can be relatively quick and easy to do. It requires much more thought and skill to take out the rest of the system. Doors can be easily serviced and adapted, the locks can be changed, different pivots can be put on, and if frame can't be salvaged then it is fairly simple to make new frames for a door.

Use designated storage areas to store the glazing. Use corner protectors and/or soft material (can be materials such as carpet tiles that are being removed as part of the strip-out) to protect the glazing during storage and handling, as well as more robust materials like corex to protect the glazing and used as barriers to cordon off the storage area.

When the glazing is removed the existing gaskets in between the glass cannot be used as they have to be cut, so new gaskets/seals need to be ordered and replaced. The existing glazing track can be removed and re-installed in the new location if it meets the required new layout.

It may be worth retaining additional glazed panels over and above the brief in case of breakages, or also if the layout changes down the line.

Understanding the client's reuse objectives as early as possible gives the best chance of success. Noting that the reuse of partitions has failed on some sites due to the cost of labour/ time it may take to demount a partition vs the amount a recipient is willing to pay.

9: PACKAGING AND STORAGE GUIDANCE

Partitions can be stored indefinitely, but in a climate-controlled environment. Glass cannot be stored for a long period in a standard warehouse or outside, as it 'spoils' and loses value quickly.

Sometimes it is not possible to get the larger panes of glass out of the building due to lack of goods lifts – hence mentioning logistics in the early considerations section - as well as the difficulty/danger associated with manual handling.

Use correct PPE e.g. safety gloves that are suitable for glass handling i.e., cut resistant, PU coating, and good sensitivity so the glass can still be felt in your hands, and Kevlar sleeves

If not already packaged, place masking tape along the sharp edges of the glass to prevent injury. If glass handling tools are not being used then apply tape to the smooth side as well. Stick masking tape in a cross shape across the glass, then tape X shapes in the boxes of the cross shape – this prevents the glass from going everywhere in the event it does shatter.

Put both corner and edge protection blocks on the glazing for protection. If protection blocks are not available then wrap the glass in thin foam sheeting (or anything soft that is available such as blankets). Cut foam sheeting down to size and tape it securely to the glass so it does not slide around. Use corrugated cardboard to encase the glass, with pieces to cover each side of the glass, including the edges, and tape these on.

When manual handling, eg when moving the panels down to the loading bay, 3 or 4 people may be required to carry a typical panel to avoid strain and also to minimise the likelihood of losing balance and dropping the glass. Suction pads can be helpful, though it is also possible (and sometimes easier) to carry by hand only.

To prevent damage or warpage, the panels need to be stacked onto stillages. This should be carried out at the loading location of the donor site, or ideally at the point of deinstallation if there is sufficient access to move a wheeled stillage through the building, and in any goods lifts.

Stillages should be suitably sized to avoid having large areas of glass overhanging (either vertically or horizontally), these need to be tested and rated to carry the appropriate weight. The total weight of glass being stacked on each stillage should be calculated prior to loading onto stillages.

Stillages should have lifting eyes to enable safe lifting with forklift or other lifting device, unless they are wheeled and planned to be lifted on/off vehicles via large tail lift.

The glass panes should be set on strips of wood or other soft material, and avoid contact with hard materials such as metal, stone or concrete. Watch out for screws or bare metal on the stillage. Avoid contact with alkaline materials such as lime and cement.

9: PACKAGING AND STORAGE GUIDANCE

Panels should be stacked evenly on each side of the stillage to avoid an uneven load which could lead to it toppling over. Panels should be therefore be added alternatively to one side and then the other.

Panels should be stacked on their edges (ie not stored flat/ horizontally). Whether it is the short or the long edge will depend on factors such as size, substance and availability of space. The panels should sit upright at an angle of between 3 to 6 degrees from the vertical - with sufficient lateral support to prevent bowing.

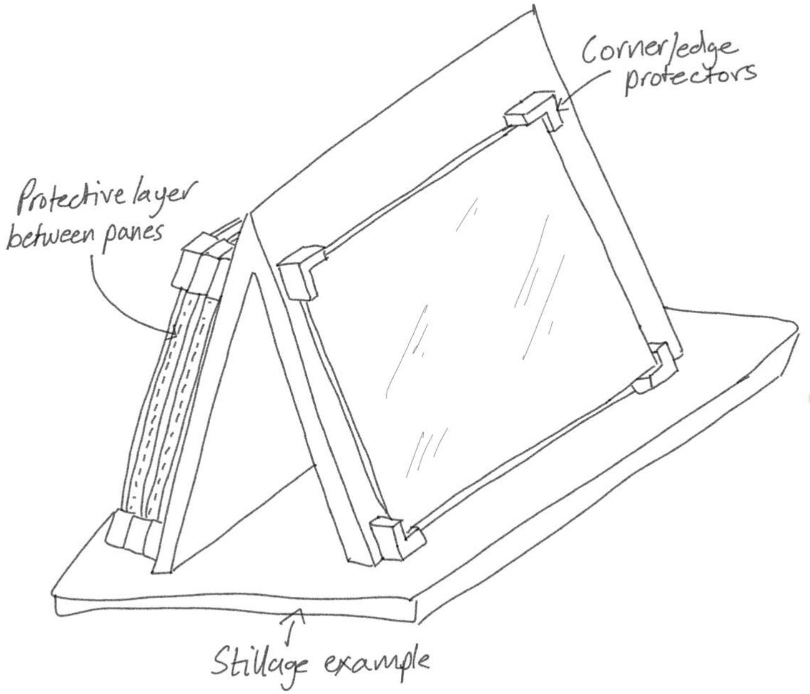
Once stacked, the glass should be strapped down to the stillage before being carefully lifted onto the collection vehicle via forklift, telehandler, or other lifting machine. Alternatively, wheeled stillages could be placed on a vehicle via tail lift as long as the tail lift is large enough (there are various sizes of tail lifts available).

The load should be distributed as evenly as possible over the vehicle axles – the lorry driver should be able to advise on this. If multiple stillages are being transported the positioning should be adjusted accordingly to ensure an even load. Make sure the total weight of the load does not exceed the payload capacity of the vehicle.

Once in place, the stillages should be robustly strapped down to the vehicle, taking care to ensure any ratchets or other solid items are not at risk of knocking against the glass. If wheeled stillages are used, sturdy chocks should also be used to lock the stillages in place and avoid sliding. Ensure there are no other items in the trailer that are at risk of sliding and bumping against the glass.

Store in a clean dry, ventilated place, away from direct sunlight or heat sources. If moisture or condensation is seen between panes of stacked glass then they should be immediately separated and dried, otherwise the panes may stick together or be permanently stained/ damaged. Avoid contact with alkaline materials such as lime and cement.

The edges of glass are by far the most vulnerable parts of a glass panel, and all efforts should be made to reduce double handling to minimise breakage during disassembly, movement, storage and re-installation.



10: RE-INSTALLATION - DESIGN AND INSTALLATION

The detailed inventory/ material passport information can be used by designers on prospective projects to integrate specific panels into their designs.

Height is usually the main constraint as more panels can be bought to make up with width, but panels cannot be cut down. Floor to ceiling height and/or size of glass pane dictate new designs using existing systems – so may need a bigger skirting with a shadow gap or a panel/ light trough at the top for example. (see also Design section earlier in this document).

Often, there are a range of panel widths used as well as some differences in height. These can be worked around with some careful design as well as the use of deeper channels and/or bulkheads.

The system provided could just be a new framework in theory but in practice it would depend on what warranty the client wanted.

Partitioning is usually built on site in stick form, whereas doors will have been taken out and stored as a framed unit.

There needs to be a dust free environment for reinstalling the glazed panels so as not to trap any dust between the panels.

The acoustics is all about the seal between the gasket and the aluminium framing, so reused glass should not have any chips on it. The 'arris edge' should be inspected, cleaned and then the pane reinstalled. (In some cases there can potentially be some allowance for very minor chips on short edges, or even on long edges where chips can be concealed by the tracks as long as the integrity of the pane is not compromised. Damage can even be repaired by glazing specialists if deemed worthwhile).

Refer to manufacturers instructions for further details of pre-glazing preparation and make sure that there are no projecting screw heads that could make contact with glass edges.

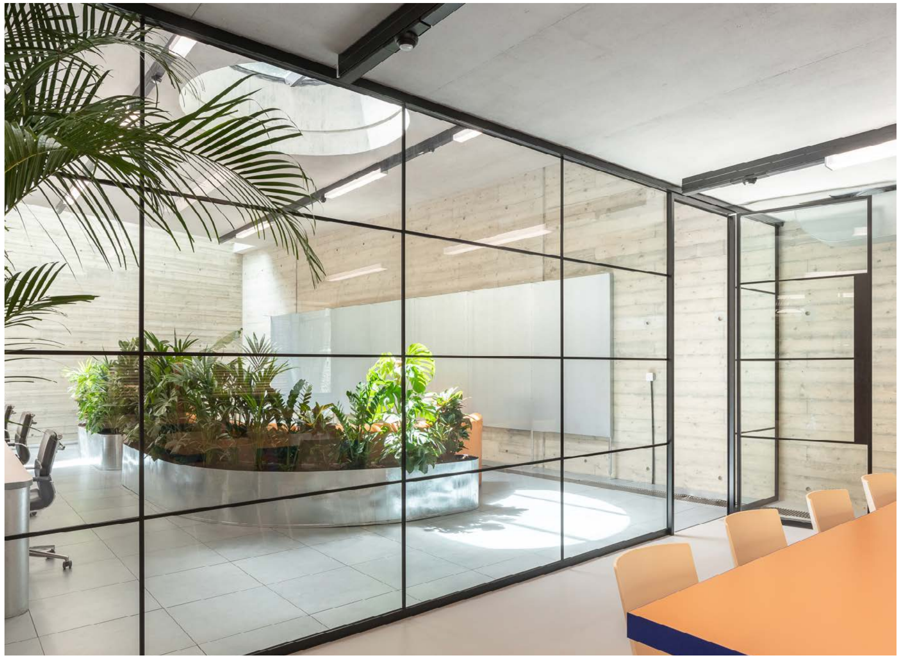


Image credit: Optima

11: WARRANTY

For in-situ partitions, what is the after-care obligation and re-warranty schemes by manufacturers? Are manufacturers looking to design for longer life?

Workmanship warranty is straight forward but would probably not cover the materials/ glass for the (part of the) framework and glass that is reused.

Acoustic performance: Acoustic testing vs acoustic verification – they are different. Acoustic verification is confirmation that the performance of the actual system installed is what the manufacturer/installer has promised on paper. Acoustic testing is what happens in scientific labs in controlled environments. Does the client want a guarantee of a certain acoustic level?

Fire-rating - not all partitions are fire resistant or need to be, check requirements. If they are fire rated, likelihood is that in the current market they would have to be reused in-situ and surveyed and retested by a fire specialist. Seek advice early and check if the client is happy to proceed with this level of risk. Otherwise they could be reused elsewhere without a need for fire rating.

Reuse can present a challenge in the absence of a single original manufacturer, it must be accepted that a new party adopts the responsibilities of a manufacturer by bringing a new kit of parts together.

And still some questions remain to be definitively answered:

If the original manufacturer is no longer in business how does that work? How do quality and warranty checks work? Does building control need to come in and do checks regarding bulkhead and head and base details if the original manufacturer is not there to do this?

Should glass partitioning be approached at a system level rather than a material level? Could it be looked at in a similar scenario to refurbishing an air handling unit or a fan coil unit, where these can be rewarrantied on site – rewarrantying the system rather than individual parts. Should we be looking at the glass partitioning *system* rather than the *individual materials*? Does this differ depending on whether it is being reused ‘in-situ’ vs ‘on another site’? Noting that it may be that the systems approach could be the only viable option for establishing either a full warranty (rather than just on workmanship) or a performance characteristic if either of these are required.

Could further research be done around the drivers for a warranty and how often this is upheld/ utilized in actuality. For example, if a partition hasn’t been maintained or checked in the prescribed way while in use, does it lose its right to a warranty anyway?

How much do we need to upskill and get the building/ facilities management teams and maintenance personnel involved – in terms of upholding any warranty given? Including making any updates to materials passport information.

12: COST, CARBON, AND OTHER MEASUREMENTS/REPORTING

Image credit: Optima. Demountable system

The prime drive for many material reuse projects is to reduce carbon emissions. One case study example states that by reusing 18.17 linear metres of partitioning and 10 doors a total of 5,238.4 kg CO_2e of emissions was avoided. Some clients will sacrifice some warranty and acoustics performance to get the carbon credits. It needs to be approached on a case-by-case basis.

Currently it is - on average, though not always - more expensive to reuse, even in-situ, so the project needs a client that wants to reuse for circularity and/or carbon emissions reduction reasons. Glass is expensive to buy, but the processes involved from deconstruction to reinstallation can be time consuming and tip the balance to make it cheaper to purchase new…

… however as reuse becomes more commonplace - increasing demand and supply - this will create economies of scale, improved processes, knowledge-sharing and better storage options, bringing the cost down. This, combined with increasing resource prices and supply chain pressures, will shift the balance towards reuse over new. See case studies for more on cost and carbon.

What is useful to report on in addition to cost & carbon?

- Amount of damage – for example % of glass panes chipped
- The % overall of the different element that are reclaimed eg mullions, doors
- Which processes are more successful than others

With glass manufacturers only paying approx. £55* a tonne for cullet (closed-loop recycling) many contractors feel it is not worth the effort, unless the client specifically requests it.

It would be interesting for a study to do a side-by-side comparison of the benefits of glass reuse vs high value recycling, including the challenges and factors taken into consideration when one solution makes more sense over the other.

*As of 2025

13: GLOSSARY OF USEFUL TERMS

Arris edge - The arris is the sharp corner between two adjacent planes or surfaces. An "arris edge" on a glass pane refers to a process that removes the sharp edges (the arris), making them less prone to cutting or damage. It involves lightly sanding or grinding the edges of the glass, effectively chamfering them to a gentle angle. This is not a perfectly smooth or polished finish, but it is a safety measure to reduce the risk of injury.

Bulkhead - In the context of glass partitions, a bulkhead is a flexible supporting structure that can be used to reduce the height of a partition (and potentially secure glass partitions from above). Bulkheads should be installed before glass is installed and can cover ceiling lights or bars that might get in the way during installation. Plasterboard is a cost-effective solution to aid the reuse of different sizes of glass partitioning and lower the overall expense if glass is not required for the full floor to ceiling height.

Db Dw - Dw is a term that relates to onsite sound insulation

Db Rw – Rw relates to the laboratory rated sound reduction index of a single element, i.e. a wall.

Fritted glass is a type of architectural glass that has a layer of ceramic frit applied to its surface. The frit is made of finely ground glass particles mixed with pigments, which are then fused to the glass during the manufacturing process by heat transfer from a tempering furnace.

Gaskets - Window gaskets provide sealing and (sound) insulation and can help hold window glass in place. They are made of rubber materials and installed along the edges of stationary windows.

Manifestation - Glass manifestation is designed to help make glass obvious and reduce injuries by preventing people from walking into the glass. Glass entrance doors and glazed screens must feature manifestations at two levels (850 to 1000mm and 1400 to 1600mm above the floor), contrasting visually with the background under all lighting conditions, to meet the requirements of Approved Document K.

A **mullion** is a vertical element that forms a division between units of a window or screen, or is used decoratively. When dividing adjacent window units its primary purpose is a rigid support to the glazing of the window. Its secondary purpose is to provide structural support to an arch or lintel above the window opening. Horizontal elements separating the head of a door from a window above are both a head jamb and horizontal mullion and are called transoms.

Soffits - A soffit ceiling refers to a section of a ceiling that is lower than the surrounding ceiling. It is a more aesthetically-pleasing ceiling finish to the ‘technical’ ceiling above that contains services, pipes and ductwork. While often used in exterior applications like eaves, soffit ceilings are also implemented indoors in a variety of ways to achieve architectural style and functionality. The difference between a standard soffit ceilings and exposed soffit ceilings tends to be that a standard soffit ceiling is typically covered with panels, creating a clear and smooth appearance; whereas an exposed soffit ceiling leaves the structural elements, like beams and ducts, visible, often giving a more industrial or modern look.

14: FURTHER READING

British Glass Net zero strategy: progress update (2024)

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