

H80 Specification

Architen ETFE Foil Cushion Systems

TO BE READ WITH TENDER DOCUMENTATION & GENERAL CONDITIONS

ARCHITECTURAL SPECIFICATION

H80.100 CONTRACTOR'S DESIGN

Completion of the design, and the preparation of all production information, shall be carried out by Architen Landrell (the Specialist Contractor) in conjunction with the Design Team.

H80.110 SCOPE OF THE WORKS

Together with the Design team, the Specialist Contractor is responsible for the Detailed Design and installation of the Architen ETFE foil cushion system including the complete detailed design of all structural interfaces with adjoining trades prior to commencement of manufacture. The Specialist Contractor is also to ensure that all interfaces are fully coordinated prior to commencement.

The Specialist Contractor will complete the detailed design, manufacture, supply, installation and warrant the works whilst complying with the visual intent on the Design Drawings submitted with tender and criteria stated in this specification.

This Specification, when read in conjunction with Design Drawings, provides particular requirements with respect to the works, which may include the following:

- ETFE (Ethylene Tetrafluoroethylene) foil.
- All associated components including Architen ETFE foil cushions, aluminium profile track, secondary drainage, gaskets, flashings, trims, bird wire deterrent, upstands/stool positions and all fixing components.
- Fritting requirements.
- Air inflation equipment to include 2 no. independent air fans, dehumidifier (if required), control unit, weatherproof housing with acoustic insulation and all air distribution pipework.
- Also, if required: Air venting system via opening panels and interface with temperature control/HVAC system linked to the BMS.
- Also, if required: Smoke venting system via opening panels and interface with smoke detection system linked to the BMS.
- Also, if required: Rain suppression system
- Also, if required: Weather station and supporting control
- Also, if required: Intelligent printing and associated control
- Also, if required, supporting steel structure including engineering, design, manufacture, paint and installation.

H80.111 MATERIAL PROPOSALS

Where no material, product or supplier is indicated in this specification, the Specialist Contractor will propose suitable materials and systems prior to contract award which comply

with the visual intent and performance criteria stated in this specification, and remain fully responsible for the Detailed Design of the works.

The Specialist Contractor shall take responsibility for the structural design of the Architen ETFE foil cushion system including the selection of the grade, number of layers of ETFE foil film and the detailed design of the perimeter flashings, aluminium profiles and design advice to the upstand positioning. Proposals will be submitted to the Contract Administrator (CA) for review and acceptance.

H80.112 DESIGN INTENT

Although a preference for a particular material, design, type of construction or dimension may be stated in any specification or on the drawings and these only indicate the design intent, both structurally and visually. In addition, no warranty is given by the CA as to the accuracy of such dimensions, the adequacy of performance, buildability of such details, or that the materials indicated are suitable/reasonably fit for their purpose.

The design, fabrication, installation and performance requirements specified are intended to establish a minimum performance level and general principles. The Specialist Contractor shall be responsible for achieving or surpassing the design and performance criteria for all components.

The Specialist Contractor will provide all necessary information to allow the client's M&E Consultant to determine the thermal and environmental performance of the Architen ETFE foil cushion system.

H80.113 INTERFACES

Together with the Design Team, complete the Detailed Design of all interfaces with adjoining trades prior to commencement of manufacture, including but not limited to:

- Supporting structure
- Structural decking
- Adjoining buildings
- Flat roof membrane systems
- Gutters and flashings
- Insulation
- Cold bridging
- Waterproofing

H80.114 TENDER/ CONTRACT DRAWINGS

Drawings have been prepared as scheduled information shown is schematic and indicative of the design proposals for the basic functional and architectural requirements. The drawings do not indicate a detailed solution, nor do they prejudice the submission of alternative proposals complying with the specified requirement.

H80.115 TENDER SUBMITTALS

Submit a draft design response with the tender proposal, to include aluminium profiles selection details, air inflation equipment and dimensions, an indicative flashing detail and build-up of the ETFE foil cushion layers of the Architen ETFE foil cushion system.

Submission to include:

- Samples as described in clause H80.117
- Quality programme

- Summary of deviations from the specification
- Outline technical specifications reflecting proposed materials/systems
- Outline technical specifications reflecting proposed air inflation equipment & control system
- List of proposed suppliers and sub-contractors intended to be used
- Initial assessment of the Architen ETFE foil cushion rise/sag
- Insulated Architen ETFE foil cushion composition
- Thermal assessment of properties of Architen ETFE foil cushion type
- Locations of similar Architen ETFE roof installations for visiting & viewing
- Predicted service life
- Overview of smoke venting options and mechanical actuation (if applicable)
- Overview of rain suppression system (if applicable)
- Proposed warranties

H80.116 ADDITIONAL INFORMATION TO BE SUBMITTED WITH TENDER

In addition to the general technical information required under clause H80.115, the Specialist Contractor is required to submit the following particulars where applicable:

- Typical plan, section and elevation drawings at suitable scales.
- Typical detailed drawings at large scales, including junctions with works by other sub-contractors.
- Technical information and certification demonstrating compliance with specification of proposed incorporated products and finishes.
- Certification, reports and calculations demonstrating compliance with specification of proposed Architen ETFE foil cushion system.
- Proposals for connections to and support from the building structure and building components.
- Proposals for amendments to primary supporting structure and for secondary supporting structure additional to that shown on preliminary design drawings.
- Schedule of builder's work, special provisions and special attendance by others.
- Preliminary fabrication and installation method statements and programme.
- Proposals for replacing damaged or failed products.

H80.117 SAMPLES, MOCK-UPS, BENCHMARKS

Sufficient samples of the following including relevant trade literature and technical specifications are to be provided in accordance with Tender requirements:

Pre contract samples:

- An A4 sample of the proposed ETFE foil.

Post contract samples (if required):

- A 500mm x 500mm sample of the proposed ETFE foil
- A 500mm x 500mm sample of the proposed ETFE foil interlayer
- A 500mm x 500mm sample of the proposed ETFE foil with fritting/printing
- A 500mm length of the Architen ETFE profile track in the proposed materials and finishes
- Typical fixings as proposed for the Architen ETFE profile track
- A detailed document outlining the proposed air inflation equipment including sizes, power requirements, weights, pipe work connections to Architen ETFE foil cushions.

- Documentation on actuator units to lift smoke vented Architen ETFE foil cushions (if required)

Mock-Up requirement:

- If agreed, a site visit to previously installed project to inspect and review installed system will negate the requirement for a mock-up (if required).

Prototype requirements:

- Provide prototypes in accordance with Tender documents (if required).

Benchmark requirements:

- The following quality benchmarks are to be provided:
 - o The first area of Architen ETFE foil cushion system comprising not less than 1 full Architen ETFE foil cushion fully installed, tested, completed & accepted by the CA
 - o Past projects built and visited by the CA

H80.118 READ IN CONJUNCTION

Where available, the following information should be read in conjunction with this specification:

- Architect's information drawings
- Structural Engineer's information
- Mechanical and Electrical Consultant's information
- Acoustic Consultant's information
- Fire Consultant's information

H80.119 APPROVALS

The Specialist Contractor shall provide to the CA, all drawings, calculations, and other technical information as may be required for the CA to submit proposals to the Building Control Officer/Approved Inspector/Fire Officer.

The Specialist Contractor shall provide to the CA, all drawings, calculations, and other technical information as may be required for the CA to submit to the CDM Co-ordinator and/or Health and Safety Officer.

H80.120 PRODUCTION INFORMATION

The Specialist Contractor shall provide the CA with production information as defined in clauses: H80.310, H80.311, H80.312 & H80.313.

H80.121 ACCURACY OF CONTRACT WORKS

In addition to any more stringent requirements specified elsewhere, the Works shall be constructed to the degrees of accuracy specified the Architects Specification.

Not less than 15 days before commencing the work specified in this section, the Specialist Contractor shall confirm, by survey relative to the CA's setting-out points, that the locations of all relevant previously-built works are correct taking account of all specified tolerances. The results of this survey shall be provided to the CA.

If the surveyed locations of the relevant previously-built works will not allow the works specified in this section to be completed within the specified degrees of accuracy, the Specialist Contractor is to immediately notify the CA and seek instructions before proceeding.

H80.122 WARRANTY

The Specialist Contractor must warrant that he has exercised, and will exercise, all reasonable skill and care in:

- Design of the Works insofar as the Works have been or will be designed by the Specialist Contractor.
- Selection of materials and goods for the Works insofar as such materials and goods have been or will be selected by the Specialist Contractor.
- Satisfaction of any performance specification or requirement insofar as such performance specification or requirement is included or referred to elsewhere in this specification.

The Specialist Contractor must review the Contract Documentation and, incorporating the warranties of material and component supplied, provide a written warranty confirming that all specified products are suitable for the expected conditions of use, in all specified locations.

H80.123 GUARANTEE

Guarantees for individual components of the overall system must be confirmed and documentation included in the Operations & Maintenance Manual.

H80.124 DESIGN LIFE OF THE INSTALLATION

The design life of the components, assemblies and installations, as defined in BS ISO 15686-1 and specified in this Section, is 30 years.

The Specialist Contractor will provide, within the Operations & Maintenance Manual, information on the methods for replacing all components and assemblies with a design life less than that of the building or less than that of the installation of which they form part.

H80.125 OPERATIONS & MAINTENANCE MANUAL

The Specialist Contractor will provide an Operations & Maintenance (O&M) Manual on completion of the Works.

TYPE OF SYSTEM

H80.200 ARCHITEN ETFE FOIL CUSHION SYSTEM

System: An ETFE (Ethylene Tetrafluoroethylene) foil cushion system comprising Architen ETFE foil cushions edge clamped to specially extruded aluminium carrier support framing assemblies and incorporating secondary drainage. The Architen ETFE Support Track will be connected to the Support Structure as indicated on the design drawings and Structural Engineer's drawings.

Manufacturer: Architen Landrell Associates Limited or equivalent
www.architen.com
T: 01291 638200

Components:

- Architen ETFE foil cushions: as clause H80.210
- Air inflation equipment: Automated with all controls, isolators, cables, air pumps, air distribution pipework and other equipment necessary for the correct and complete installation of the works. The Architen ETFE foil cushions shall be inflated to the recommended pressure levels, which shall be maintained by the electrical

motor operating backward air fill blower units (minimum 2 no for each system) and a dehumidifier (if required) within weather housed unit. The system shall include air distribution pipework, wiring, air pressure monitors and switches and all associated components for the full operation of the system. The air management system is to be supplied with the ability for integration with a BMS system. Primary and secondary fans shall be able to maintain positive pressure within the Architen ETFE foil cushions to ensure stability of the form and appearance of the Architen ETFE foil cushion. Fans shall be operated by a frequency pressure switch connected to a reference Architen ETFE foil cushion (normally mid span from main machine)

- Support Structure (where required): Support Structure to Structural Engineer's specification, including perimeter beams, horizontal trusses and vertical posts as required. The Specialist Contractor's working drawings will show the final extrusion design while maintaining the CA's visual requirements as indicated on the Design Drawings.
- Architen ETFE Support Track: Extruded aluminium, thermally broken support system with mechanically restrained top aluminium caps, with sealed edge clamps, to receive Architen ETFE foil cushions and incorporated verge flashing. Finish to be confirmed.
- Cables: Grade 316 stainless steel cable system manufacturer's recommendations.

Accessories:

- The system shall include all support bracketry, fixings, drainage channels, Architen ETFE foil cushion restraints, seals, clips, spacers, isolators, gaskets, flashings, bird wire deterrent, closures and ancillary items/accessories necessary to complete the fabrication and installation of a smooth free draining surface.
- Perimeter flashing to be PVC or PPC coated steel/aluminium
- RAL dark or light grey as standard.
- Top aluminium capping to Architen ETFE Support Track are to be installed flush with Architen ETFE foil cushions to prevent ponding.
- The extrusions carrying the Architen ETFE foil cushion system shall incorporate a secondary drainage system.

H80.210 ARCHITEN ETFE FOIL CUSHIONS

Material:

- System to consist of pneumatic cushions made up of modified copolymer Ethylene Tetrafluoroethylene (ETFE) extruded into thin films:
 - o Outer layer: Nominal 200um, pattern (fritting pattern as defined in clause H80.427) to manufacturer's recommendations to achieve the required solar performance.
 - o Intermediate layer: Nominal 100um, clear to manufacturer's recommendations to achieve the required solar performance.
 - o Bottom layer: Nominal 200um, clear to manufacturer's recommendations to achieve the required solar performance.

Inflation:

- Inflation shall be by air inflation units. At least two fans shall be incorporated with each unit capable of maintaining the Architen ETFE foil cushions, which it serves at

the design inflation pressure when 10% of the Architen ETFE foil cushions are damaged.

- A dehumidifier will be incorporated where necessary.
- Air handling units will be supplied with a standard 16amp CEE-form power inlet, to allow easy connection to an alternative power supply if required.

Control system:

- The control system shall be designed such that, at any one time, the two fans run on a duty cycle to share load and prolong the life of the blowers. The control system will monitor operation of each fan and will dynamically fail over in case of malfunction/failure
- Pressure sensors will be located in two cushions and continuously monitor the air pressure, feeding information back to the control system. Pressure control will adapt the fan speed to compensate for increases and decreases in pressure to maintain a steady level.
- The control system shall be linked to an LCD screen mounted on the front of the air handling unit (AHU) and display the current system pressure and pressure set point along with operation status.
- The control system will be supplied with a volt-free output for connection to BMS.
- Integration of the following additional functionalities can be supplied if required:
 - o Remote control panel
 - o Wind monitoring
 - o Snow monitoring
 - o Remote GSM monitoring
 - o UPS
 - o Power sourced from photovoltaic panels
 - o Power sourced from wind turbines

Other requirements:

- The control system shall be designed to ensure that the stand-by unit will cut in automatically should the operational unit fail.
- The inflation units shall be supplied with external air or, if not available, air from a low humidity source.
- The system shall include air distribution pipework, wiring, air pressure monitors and switches and all associated components necessary for the full operation of the system.
- The Architen ETFE foil cushion panels shall be manufactured to, and designed to suit, sizes indicated on the Design Drawings with reinforcement as necessary to meet all loading conditions and internal wind loading criteria specified by Structural Engineer.
- The Architen ETFE foil cushions shall make provision for the integration of a rain suppression system.
- All loadings, dead and imposed, to the roof structure shall be confirmed by the Structural Engineer and the proposed roof structure confirmed as being able to carry these loads.
- Provision shall be made for the integration of system for access/ maintenance, subject to further investigation and development
- Fixing of the Architen ETFE foil cushions will allow replacement without disturbing adjacent ETFE foil cushions.

- Also, if required: The Architen ETFE foil cushion system will be supplied with air venting system via opening panels and interface with temperature control/HVAC system linked to the BMS.
- Also, if required: The Architen ETFE foil cushion system will be supplied with smoke venting system via opening panels and interface with smoke detection system linked to the BMS.
- Also, if required: The Architen ETFE foil cushion system will be supplied with rain suppression system to meet the requirements of Acoustic Consultant.
- Also, if required, The Architen ETFE foil cushion system cushions will be supplied with supporting structure including engineering, design, manufacture, painting and installation.

GENERAL REQUIREMENTS

H80.300 DESIGN

Architen ETFE foil cushion system and associated features: The Specialist Contractor will complete the detailed design and submit before commencement of fabrication.

Related works: The Specialist Contractor will coordinate in the Detailed Design.

H80.310 INFORMATION TO BE PROVIDED WITH TENDER

See clauses H80.114 & H80.115

H80.311 INFORMATION TO BE PROVIDED DURING DETAILED DESIGN STAGE

The Specialist Contractor will submit, where relevant, the following particulars:

- A schedule of detailed drawings and dates for submission for comment.
- A schedule of loads that will be transmitted from the Architen ETFE foil cushions to the structure.
- Proposed fixing anchor details relevant to structural design and construction.
- A detailed testing programme in compliance with the Main Contract master programme.
- A detailed fabrication and installation programme in compliance with the Main Contract master programme.
- Information to support outstanding applications for Building Regulation consents or relaxations.

H80.312 DETAILED DRAWINGS

The Specialist Contractor will submit, where relevant, the following particulars as a minimum:

- Setting-out and control points.
- Tolerance dimensions indicating both the location of components and the width of all joints.
- Identification of components.
- Details of isolation, packing, and shimming.
- The locations of all sealants, with details of position, type, and size of backing rods, bond release tapes, and the like.
- Embedment, spacing and edge distances for fixings.
- The type, size, and spacing of all welds.

H80.313 DETAILED CALCULATIONS

The Specialist Contractor will submit, where relevant, the following particulars as a minimum:

- Structural Calculations: For all sections, connections, anchorages, support assemblies and the like.
- Thermal Calculations: To support the claimed insulation values of all Architen ETFE foil cushions, frame sections, and other insulated components.
- Condensation Prediction Calculations: To identify the probability of internal, external, or interstitial condensation forming and, where the calculations indicate that condensation is likely to occur, the quantitative rate of formation together with an explanation as to how the proposed design eliminates any damage or inconvenience caused by the condensation so formed.

H80.314 PROJECT SPECIFIC METHOD STATEMENTS

As a minimum:

- Manufacturer's recommendations for the use of proprietary fixings.
- Information on all bolts and fixings requiring specific torques together with details of the required torque levels.
- Information on the location and use of locking nuts and washers, engagement of serrations, and the like.
- Information on the cleaning and, if required, priming procedures for all sealants.
- Details of points which are susceptible to damage, or which should not be loaded during installation.

H80.315 PRODUCT SAMPLES

General: Before commencing detailed design, the Specialist Contractor will submit labelled samples of:

- Samples of ETFE foil proposed for use in the works
- Proposed colour samples, 300mm x 300mm minimum size.
- Proposed extrusions minimum 300mm in length.
- Fastening devices and anchors.
- Bolts and exposed fittings.

DESIGN/ PERFORMANCE REQUIREMENTS

H80.400 DESIGN/ PERFORMANCE REQUIREMENTS

The Architen ETFE foil cushion system generally shall be designed, engineered, constructed and installed in accordance with the material manufacturer's recommendations.

The Architen ETFE foil cushions shall be inflated to the designed pressure levels, which shall be maintained by the air inflation equipment.

Architen ETFE Support Framing shall be designed not to utilise any strength or rigidity imparted to the assembly by the Architen ETFE foil cushion.

Structural use of aluminium shall recognise criteria contained in BS 8118: Part 1, which includes limiting deflections.

The number and thickness of the ETFE foil layers and the inflation pressures of the Architen ETFE foil cushions shall be determined by Architen Landrell to comply with the specified performance requirements.

The Architen ETFE foil cushion system shall be designed to remain in tension under normal loading conditions and present fall to discharge rainfall. Slack foil or foil inversion may occur for extreme loading conditions such as drifted snow or extreme wind cases. Foil stresses to be limited to 1st yield point for all unfactored cases.

Due account shall be taken of any relaxation in the ETFE foil tension over time when calculating installation systems.

The minimum fall requirement to allow water run-off is 6 degrees to a standard roof, however Architen Landrell can offer a drainage system for a more horizontal roof design if required.

H80.410 DURABILITY

The performance criteria shall be satisfied for the full service life of the works, as stated in the specification, provided that the appropriate maintenance has been carried out as specified within the Architen Landrell O&M Manual and executed by experienced and qualified Architen Landrell Maintenance Personnel (or equal approved).

H80.411 PRIMARY & SECONDARY COMPONENTS

Primary and secondary components are all to be Architen Landrell components necessary for the stability of the Architen ETFE foil cushion system.

- All supporting framework is aluminium anodised as standard
- All fixings are stainless steel as standard
- Secondary components are components capable of being replaced, maintained and not essential to the stability of the cushion system as follows:
- Sealants capable of replacement.

H80.412 LOCAL FACTORS

Visit the site in order to become familiar with local requirements. Local microclimatic conditions shall be taken into account and grades of materials assessed as suitably durable for the location shall be selected.

An assessment of micro climatic conditions shall be made under instruction from the CA with due allowance for any factors likely to have an adverse effect on materials intended for the works. More appropriate materials shall be substituted if adverse effects are predicted.

H80.413 DESIGN LOADS

The system shall be designed to withstand the loads as specified below without affecting the system's ability to meet the specified performance requirements and/or the exceptional loads specified herein. Unless otherwise stated, the system shall also be designed to comply with all prevailing relevant British and European Standards as appropriate, including, but not necessarily limited to BS 6180 and BS 6399.

All wind calculation data submitted under a full design order relating to the ETFE wind loads are to be reviewed by the Structural Engineer, Architect and CA. All calculations will be based on British Standards relating to BS 6399-2: Part 2 Code of Practice.

The loads created by adverse weather conditions shall be accommodated safely, without detriment to the overall design, structural integrity and performance of the works.

The permanent fixings of any component shall be capable of resisting the combined dead load and maximum wind load with a factor of safety of at least 1.5

Self-weight Gravity Loads: The works shall be capable of accommodating the self-weight of the system including all of its framing and supporting system including increased weight due to water collection, snow, snow drift and ice.

Loads resulting from routine cleaning, maintenance and repair activities shall be identified and taken into consideration in the design of Architen ETFE cushion system and associated parts in accordance with CDM Regulations.

Fatigue: All framing members, connections and welds shall be designed to avoid metal fatigue requirements in compliance with the relevant standards as applicable.

H80.414 FRAGILITY

The works shall comply as a minimum with Category C status with regard to the HSE requirement of 'Test for Fragility of Roofing Assemblies' to category as specified.

H80.415 LIVE LOADS

The works shall be capable of accommodating the following live loads, to BS 6399: Parts 1-3, without any reduction in performance:

- All loads resulting from movements of the building structure and Support Structures.
- Known impact loads, or transferred impact loads, that occur during its service life, without deterioration in performance and without sustaining non-repairable damage.
- Loads imposed during maintenance and/or replacement of panels/units.
- Wind loads as advised by the client engineer. Wind shall be accommodated safely, without detriment to the overall structural integrity and performance of the roof.
- Snow loads as advised by the structural engineer. Snow and ice shall be accommodated safely without detriment to the overall structural integrity and performance of the roof.
- Vertical loads of similar magnitude to those which are imposed upon adjacent or attached elements. Refer to the Design Drawings for information on such elements and/ or required load capacities.
- Point loads imposed on the framing members of 695N (refer to design drawings), inwardly acting, based on Appendix E of BS 5516 parts 1&2. Maintenance loads shall not be carried by the infill panels.

H80.416 IMPOSED MOVEMENTS

The works shall be capable of accommodating loads imposed upon the system by defined movements of its supporting structure and/ or other adjacent elements.

H80.417 SPECIFIC MOVEMENTS

The works shall withstand all movement of the structure under all design loads or combination of loads without damage or reduction in performance.

Refer to the Structural Engineer's specification for movements associated with the primary structure.

Expansion and movement joints shall accommodate the appropriate range of movement.

H80.418 IMPOSED GRAVITY LOADS

The works shall be capable of accommodating loads imposed by adjacent and/or attached elements that bear onto or are suspended from or fixed to the system. Refer to the design drawings for information on such elements and/or required load capacities. All information

relative to any attached/bear onto/suspended elements must be made available prior to structural calculations and design.

H80.419 INERTIAL LOADS

Where appropriate, the works shall be capable of accommodating inertial loads arising due to the acceleration/deceleration of moving sections including opening lights, doors and vents of the building or enclosure.

H80.420 WIND/ AIR PRESSURE LOADS

Calculated pressure loads shall include the effect of internal air pressures within the taking into account the presence of significant openings, which might arise occasionally within the building enclosure.

The Specialist Contractor must take provisions to eliminate vibration and noise.

H80.421 THERMAL MOVEMENT

The system shall be designed to accommodate thermal movement resulting from the maximum and minimum surface temperatures.

The works, including all necessary Support Structure, shall be designed to be capable of accommodating changes in dimension and shape of its components resulting from changes in temperatures ranging from -15°C to +50°C and from differential surface temperatures between the inside and outside of the building without any reduction in the specified performance. The design shall cater for all temporary and permanent conditions envisaged for the works.

The Specialist Contractor will ensure that thermal movements shall not result in unacceptable levels of audible noise.

H80.422 THERMAL PERFORMANCE

The thermal performance of the Architen ETFE foil cushion system can be subject to further analysis and development based on Mechanical and Electrical Consultant's requirements.

The average U-value for a standard Architen ETFE foil cushion system shall be:

2 layer: 2.94 W/m²K
3 layer: 1.96 W/m²K
4 layer: 1.47 W/m²K

The Architen ETFE foil cushion system shall have its thermal properties determined by reference to the total energy requirements of the building, or the U-value calculated in accordance with the Building Regulations Approved Document L.

Where required, the Specialist Contractor will submit thermal calculations with support from the CA's M&E consultant for the various components of the Architen ETFE foil cushion system and the average thermal performance of the proposed Architen ETFE foil cushion system.

H80.423 MOISTURE MOVEMENT

The works shall withstand movement without permanent deformation or any reduction in the specified performance:

- Due to changes in the moisture content of its components, resulting from variations in the moisture content of the air.
- Due to the expansion of absorbed or retained moisture caused by freezing.

Allowance shall be made to control the flow of any water that may collect behind the element and for directing this water to the outside perimeter edge, via the secondary drainage system.

H80.425 AIR PERMEABILITY/ INFILTRATION

The Detailed Design shall minimise airflow from the outside to the inside of the Architen ETFE cushion system through joints/junctions to control concentrated airflow.

Air leakage shall be distributed and not concentrated at any one location.

H80.426 LIGHTNING PROTECTION

Where required, provide studs/bolts on the Support Structure for subsequent connections to be made by the lightning protection contractor.

H80.427 SOLAR PERFORMANCE

The Architen ETFE foil cushion system shall meet the following criteria:

- Architen fritting pattern reference: _____ or clear
- Light transmission: To be confirmed
- External emissivity: To be confirmed
- Internal emissivity: To be confirmed
- External solar reflectance: To be confirmed
- Internal solar reflectance: To be confirmed
- External solar absorptance: To be confirmed
- Internal solar absorptance: To be confirmed
- Total solar transmission: To be confirmed

Data sheets for project specific build-ups in accordance with BS EN 410 (light transmittance, radiant transmittance of glazing) with tolerances of $\pm 3\%$, shall be submitted in respect of solar and visible light performance.

The specified light transparency shall be achieved across the visible light region of between 380-780nm.

The works shall be designed to ensure that the Architen ETFE foil cushion system does not distort or are damaged in any way through differences of temperature on the surfaces of the works.

All specified criteria are nominal values.

H80.428 CONDENSATION

Except under extreme conditions where the relative humidity is in excess of a percentage value as determined by the Services Engineer, condensation shall not form, either on internal or external surface of framing members, Architen ETFE foil cushions, solid panels or louvres, or interstitially within the construction of the works, such that it may lead to damage or staining.

Condensation shall be permitted in non-visible, drained and ventilated rebates subject to condensation not having a deleterious effect on performance or durability.

H80.429 WEATHER AND WATER PENETRATION RESISTANCE

The works, including flashings and junctions with adjacent parts of the building, shall be fully weatherproof and watertight under all conditions with full allowance made for deflections and other movements.

The Design Drawings and construction of the works shall be such that all rigid or fixed joints shall remain rigid and accommodate all thermal, building structure or other movements and any applicable loads without compromising its watertightness.

The aluminium extrusions carrying the cushions shall incorporate a secondary drainage system to include condensation outlets as standard.

Secondary drainage with external weep outlets shall be standard and incorporated into the design.

H80.430 CAPILLARITY

The detailed design gaskets, seals, etc., shall take account and eliminate any possibility of water migration to the inside of the building due to capillary action to the satisfaction of the CA.

H80.431 FLASHINGS/TRIMS

PVC or PPC coated metal to all perimeter flashings, all joints shall make full weather seal. Colour from RAL range. Externally exposed PVC coated flashings and trims shall have weatherproof inter-connecting joints with sealant application where required.

H80.432 BIRD DETERRENT

Architen Landrell to provide a spring-loaded bird deterrent system to all cap plates of the aluminium extrusion including valleys and to all perimeters where necessary, ensuring access for maintenance can still be achieved. Requirements to deter specific birds will require notification to Architen Landrell.

H80.433 DEMOUNTABILITY

Elements of the works shall be individually and independently removable ensuring access for maintenance.

The removal of units shall not affect the performance or safety of any other part of these, or adjacent, works.

H80.434 SEALANTS

Sealants are to be in accordance with section Z22.

H80.435 GASKETS

Gaskets are to be made of extruded silicone rubber or Ethylene Propylene Diene Monomer (EPDM) as required.

H80.436 JOINTS GENERALLY

Movement joints are to be as shown on the design drawings.

The work must accommodate all movement of the joints in a manner that does not compromise the integrity or appearance of the system.

H80.437 FIXINGS GENERALLY

All fixings shall generally be stainless steel.

All necessary fasteners and fixings shall be provided for the works and associated flashings and closures.

H80.438 FIRE PERFORMANCE

All elements of the works shall be either non-combustible or not easily ignitable with low flame spread characteristics, and shall not produce excessive quantities of smoke or toxic gases.

All materials used shall accord with all relevant and applicable regulations including the Building Regulations and Fire Services Department. Materials shall be Class 0 when tested in accordance with

BS 476: Parts 6 and 7, unless otherwise specified.

The ETFE foil shall meet the following requirements:

- Minimum melting temperature of 270°C for all layers. Classified as Euro class B-s1,d0
- Self-extinguishing.
- Minimum low flammability category B1 when tested to DIN 4102.
- Oxygen index (LOI) of 35% when tested to ASTM D 2863.
- Class 0 when tested in accordance with BS 476: Parts 6 and 7.
- Minimum classification of M2 (no burning drips) in accordance with NFP 92-501 and NFP 92-503.

Smoke venting:

Option: Where required, the Architen ETFE foil cushion system shall be designed to lift/open using mechanical actuation to act as a smoke vent in the event of fire. When critical to the fire engineer's plan, the system must be linked to an automated Building Management System and tested on an annual basis by the local Fire Department.

H80.439 ACOUSTIC PERFORMANCE

Acoustic absorption:

Option: Where required, rain noise can be controlled by the application of the Architen Landrell Rain Suppression System. Separate costs and sound reduction data can be provided for the 'Retro-Fit' option upon request of this item.

H80.440 SERVICES CO-ORDINATION

Cable and air supply pipes shall be run in inconspicuous or concealed locations and, wherever possible, framing sections shall be capable of containing service runs.

The location of any services, cables, ducts or pipes running along the line of the Support Structure or adjacent elements of the works shall be clearly shown on the Working Drawings and shall not be installed until their proposed routing is accepted by the Architect.

H80.441 MAINTENANCE

Detailed advice on on-going maintenance shall be provided and agreed at Tender Stage. Provision, scope, and costs of maintenance contract to be confirmed at Tender Stage, and agreed with client and servicing sub-contractor, as necessary.

FABRICATION

H80.500 ASSEMBLY

Carry out as much assembly as possible in the workshop.

Joints, other than movement joints, must be rigidly secured, reinforced where necessary and fixed with designed abutments.

Take precautions to prevent displacement of components in assembled units. Obtain approval for any reassembly on site.

H80.510 INSPECTION

All fabrications and assembled units shall be carefully inspected for match with accepted samples and for compliance with the Architectural Specification and the final Working Drawings before dispatch to site.

Provide adequate notice of inspection arrangements to enable the Architect and/ or other affected parties to be present.

H80.511 TOLERANCES

All tolerances, including dimensional tolerances of all accessories and components, shall be within an acceptable range and in line with the Architen Landrell Quality Procedures.

ETFE CUSHION SYSTEM INSTALLATION

H80.600 GENERALLY

The works shall be manufactured with continuous profiles being free from marks, defects, flaws, steps, waves, or damage of any nature.

Fabricators and installers must employ competent operatives. Records of their experience are to be provided to the CA on request, installation technicians' certificates are to be provided.

All elements of framework and associated beads and strips shall be stored on site such that they are not damaged, distorted or weathered unevenly.

All finished components shall be carefully packed in stillages or crates such that they are separated and protected to prevent scratching, scuffing, or other surface damage. Mark or tag all products to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the complete installation.

All cladding, sealants, and gaskets shall be stored on Site in accordance with the manufacturer's written recommendations.

Dimensions and levels of the structure shall comply with the requirements of clause H80.511 and shall be verified before installation of the ETFE support track commences.

The framing members for the works shall be set out and installed in the correct position, within tolerance, and in the correct relationship to the building structure.

All fixing bolts and anchors shall be installed in accordance with the manufacturer's recommended procedures. Secure anchors through holes formed during fabrication only. Tighten all mechanical fixings to manufacturer's recommended torque figures. Do not over tighten fixings intended to permit differential movement.

No heating shall be carried out which may result in material properties that do not conform to the specified requirements for the 'as-supplied' material.

Avoid the collection and entrapment of swarf, dust and construction debris, within the interstices of the Architen ETFE support track.

The CA shall be informed before drilling or cutting parts of the structure, other than where shown on the Working Drawings.

Due consideration shall be given during Detailed Design to eliminate/minimise galvanic corrosion between similar metals.

The works shall be square, regular to line, level, and plane, with all junctions fitting to the stated tolerances.

All works shall be installed to give the necessary edge cover and clearance to ensure a permanent and safe installation.

All works shall be capable of replacement. A method statement showing the method of removing damaged Architen ETFE foil cushion and any associated metal framework and installing new components shall be made available if required.

Advertising or other stickers, labels or the like shall be removed from the system/materials/products on arrival at site, and all others similarly throughout the duration of the works.

In line with Architen Landrell Quality Procedures, each individual Architen ETFE foil cushion will be permanently identified with a serial number for future reference.

H80.610 ETFE SUPPORT TRACK

All corners are to be flush, flat and true. Corners will be mitred where appropriate.

Frames shall have a fully fitted gasket with sealed corners in the same plane and forming the air and vapour barrier.

ETFE support track shall safely and securely retain the Architen ETFE foil cushion system.

Joints, other than movement joints, must be rigidly secured, reinforced where necessary and fixed with maximum 20mm gap at butt joints.

All Architen ETFE Support Track shall utilise the minimum cross section necessary to maintain rigidity and performance.

H80.611 PREVIOUS EXPERIENCE

Provide details demonstrating at least five years' experience in the designing and erecting of Architen ETFE foil cushion system.

Give details of directly employed Site Technicians experienced in erecting Architen ETFE foil cushion system.

Give details of dedicated local office and facilities management services available.

H80.612 SUITABILITY OF STRUCTURE

Take precautions to prevent displacement of components in assembled units. Obtain approval for any reassembly on site.

H80.613 PROTECTION

All fabrications and assembled units must be protected against damage, corrosion and disfigurement during handling and installation.

Protective coverings must be applied before dispatch to site and must not be detrimental to membrane roofing products, finishes or installation procedures.

Upon sectional completion of each Architen ETFE foil cushion, it is handed over to the Main Contractor who will take responsibility for the protection thereafter.

Remove protective covering only when necessary to facilitate installation and from surfaces which will be inaccessible on completion.

Immediately remove spills and monitor the Architen ETFE foil cushion system to ensure that any spill of a deleterious nature is removed immediately after it occurs.

H80.614 INSPECTION

All fabrications and assembled units shall be carefully inspected for match with accepted samples and for compliance with the Architectural Specification and the final Working Drawings before dispatch to site.

Provide adequate notice of inspection arrangements to enable the Architect and/ or other affected parties to be present.

H80.615 ETFE CUSHION SYSTEM TOLERANCES

A high degree of accuracy must be employed in the installation of the works and associated Support Structures to the Architen ETFE foil cushion system. The design is based on the steel supporting structure tolerances as defined in the National Structural Steelwork Specification.

On-site dimensions: are to be checked with reference to the "Movement, Tolerances and Loadings Schedule". The finished installation is to accommodate all differences between actual site dimensions and dimensions within the above tolerances.

All return edges to metal components shall be formed to a minimum external bending radius of 2.5T. Confirmation of the preferred radius, which shall be consistent throughout the works shall be given to the Architect for review.

Length/ Width: Maximum allowed deviation is the lesser of 10mm or $\pm 0.05\%$ of design dimension.

Thickness/ Depth: Maximum allowed deviation is $\pm 3\text{mm}$ at edge.

Squareness: Any diagonal length across the panel shall not deviate by more than the lesser of $\pm 20\text{mm}$ or $\pm 0.075\%$ of design dimension.

Straightness: Any surface or edge shall not deviate by more than 5mm from a 2m straight edge placed against it in a direction parallel to the long axis of the element.

Flatness: Any surface shall not deviate by more than 5mm from a 2m straightedge placed against it in any direction.

Joints between: The average width of any joint shall not deviate from the nominal width by more than +/-10mm. Any variation shall be equally distributed with no sudden changes or steps.

The maximum variation in plan location from the planning grid of, and height from, any part of the works shall be +/- 10mm.

The maximum offset in plane, level, or section between any 2 adjacent parts of the system shall be +/-3mm.

Cut-outs for interfacing works shall be to the dimensions shown on the working drawings +/- 10mm.

All bolts in slotted holes shall be within 2mm of their intended position.

Sufficient analysis of the erection sequence and the overall method statement shall be performed to ensure that the installation tolerances described above are met.

TESTING

H80.700 TESTING GENERALLY

Provide standard testing data demonstrating that the Architen ETFE foil cushion system meets the performance requirements of the specification to the satisfaction of the CA or carry out tests to demonstrate compliance with the requirements of the specification. Unique tests will incur a lead in time and cost advice prior to instruction.

The Specialist Contractor will submit all available standard test data, free issue, for review and acceptance by the CA and be advised if a requirement for project specific tests is deemed necessary. Where testing is required, the ETFE structure manufacturer/contractor shall carry out any design tests required by the client to be and witnessed/certified by the CA or a nominated representative.

Free issue standard test data can be provided with Tender returns where required. Project specific tests will be priced separately upon request with required lead in times.

Project specific tests can be carried out for the following:

- Pressure tests on air distribution pipework
- Tests for mechanical properties of materials
- Inflation test for Architen ETFE foil cushion system
- Operation tests for the air handling units
- Long term elastic behaviour of the Architen ETFE foil cushion system
- Solar performance
- Fire performance
- Acoustic performance

Test data offered to the CA, whether standard or project specific will be presented in a format to support their ability to achieve certification with Building Control and Fire Authorities.

H80.710 SITE HOSE TESTING

The Specialist Contractor will carry out site hose testing where required. Tests will comprise:

- Inspection of the completed installation and preparation for water testing.
- Protection of any adjacent constructions to prevent damage
- Completion of a spray water test to demonstrate waterproofing requirements and an entirely waterproof enclosure.

H80.711 AIR LEAKAGE TEST

The Specialist Contractor will carry out tests to ensure air leakage from the Architen ETFE Cushion System is within reasonable parameters.

Testing of the air permeability of the building envelope is the responsibility of the Main Contractor.

H80.712 TESTING OF FIXINGS

As the works proceed, allow for 5% of all bolts to be torque tested and a documented report signed off by the Specialist Contractor's Site Supervisor confirming that the random torque y=est has been carried out to ensure compliance with section Z20 of the specification.

H80.713 NOISE AND VIBRATION

The works shall not vibrate so as to cause noticeable noise or vibration including transmission to other elements of the works or into the building frame.

The flow of wind over the works shall not cause audible noise effects from wind flow, including transmission to other elements of the works or into the building frame.

H80.714 RESULTS/ CERTIFICATES

Tests and inspection results shall be submitted as soon as they are available.

Submit certificates relating to the materials used in the work as confirmation of tests carried out in accordance with the relevant British Standards, and/ or other national standards as appropriate.

Maintain, until the end of the defects liability period, records of all inspections and tests performed, material certification, inspection and test plans, drawings, and any other documentation to substantiate conformity.

The records shall be stored in such a way that they are identifiable to the component to which they refer and are retrievable.

The records shall be available for inspection by the Architect and copies of records shall be given to the Architect upon request.