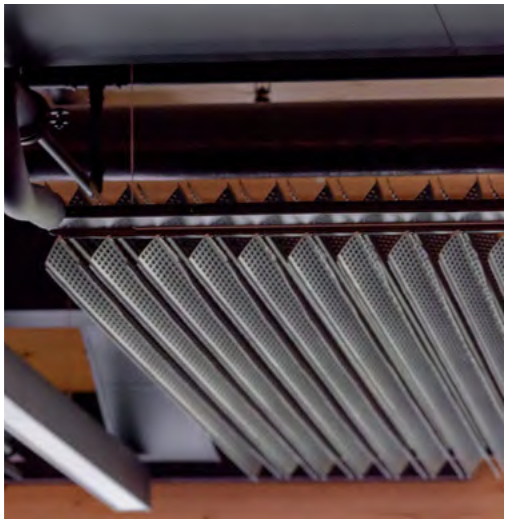
the future of space conditioning

X-Wing®

passive “Radiant” chilled beam



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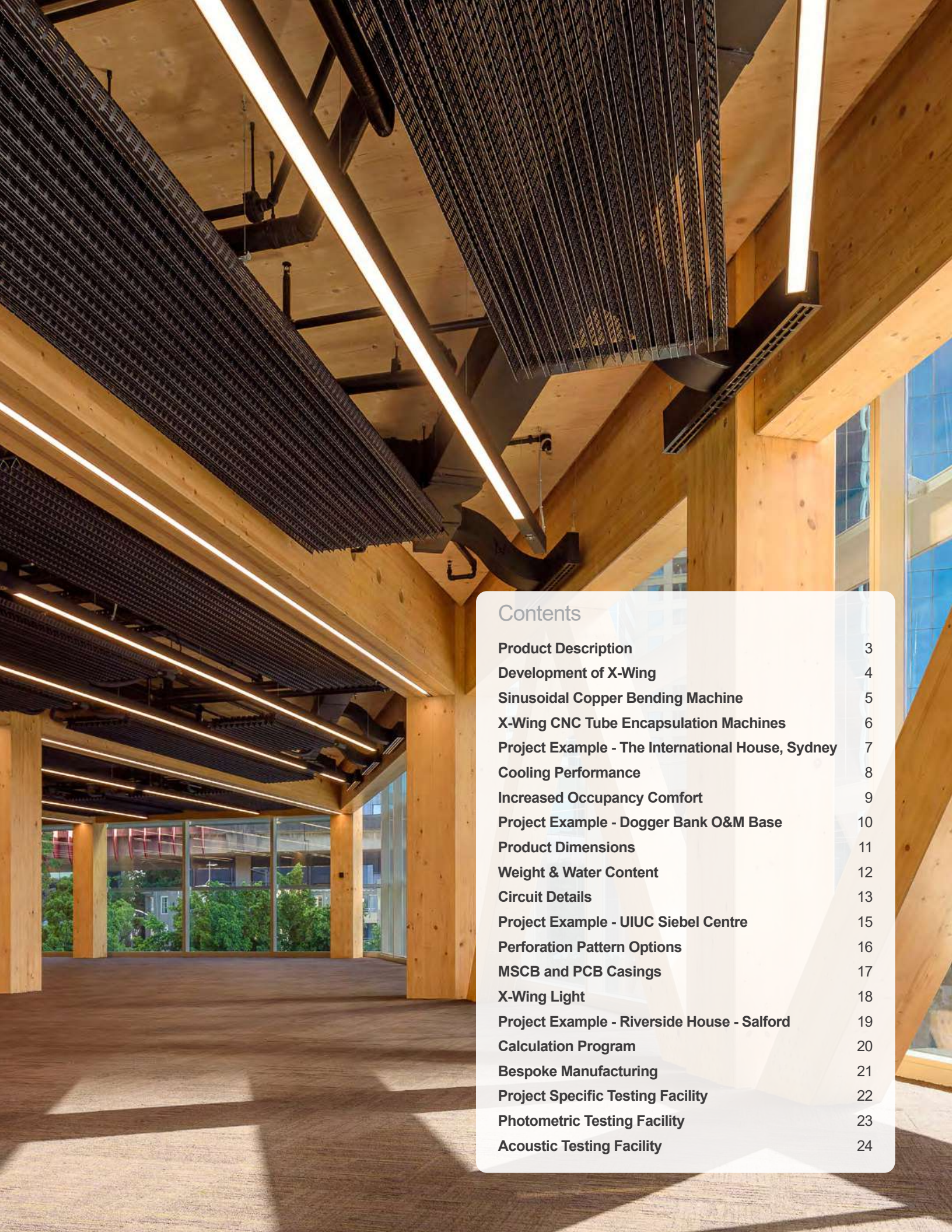
FTF GROUP® Climate



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Product Description

X-Wing is one of the FTF Group's latest range of next generation Chilled Beams. Energy efficiency has been a key driver for such advancements in the FTF Group's Chilled Beam Technology.

X-Wing is only **4 15⁄16" deep** and can achieve up to **384 Btu / hr / ft as an exposed passive "Radiant" / convective cooling** unit and up to **50 BTU / hr / ft² when concealed behind an S5046 perforated metal ceiling** (both sets of maximum performance are based on 18dTF).

NB. The above performance figures are waterside cooling and no inclusion made for any additional cooling effect from any separate supply air system for respiratory requirements.

X-Wing contains a number of **Patent pending performance enhancing features**, as can be expected from the FTF Group brand.

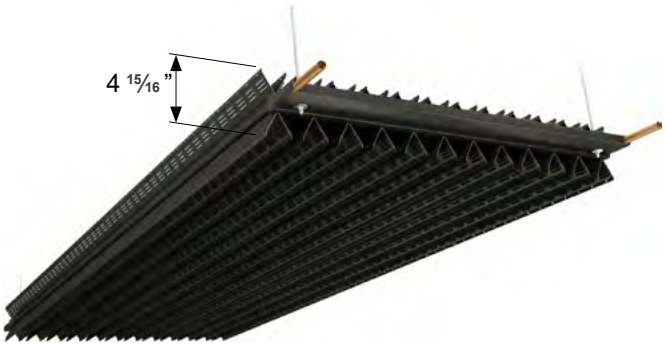
X-Wing is constructed from copper and aluminum and is 100 percent recyclable. The copper coil is produced by the FTF Group's in house fully automatic bespoke "state of the art" serpentine bending machine. This produces seamless sinusoidal copper coils (without any joins) up to 18 3⁄8ft in length, with up to 12 water passes at 2 3⁄4" tube centers. The aluminum radiant "wings" are produced in house by bespoke power press and roll forming machines, all of which are then assembled by the FTF Group's fully automatic CNC controlled machine which mechanically bonds the "radiant wings" to be in metal to metal contact with the seamless copper waterways and thus providing 100% encapsulation of the waterways for optimum transfer of energy from the radiant wings to the copper waterways.

The finished products are hydraulically tested to 246 Psi positive pressure as standard before automatic machine wrapping and packaging.

The FTF Group, have automated the vast majority of processes for **this particular next generation product to ensure that the highest levels of quality are both repeatable and consistent at all times.**

Function

X-Wing provides cooling by both convection and "Radiation". The radiant proportion creates no air movement, the only air movement comes from the convective proportion. As cold water passes through the chilled beam the warm room air is cooled against the beam's cooler surfaces. This cooled air, which is heavier due to it's higher density, then streams through the punched louvers in the radiant wings and percolates through the small ceiling perforations into the room space below (when concealed). In this way air is circulated within the room, with warm air from the room being continually replaced by cooled air.



In addition to this convective cooling process, the cold surfaces of the beam (the radiant wings / 4 per waterway) also absorb heat radiation from the building occupants and the warmer surrounding surfaces. X-Wing's radiant quotient is approximately 40% of the total cooling effect (the other 60% of cooling being generated by the convective cooling effect described above). The ability of X-Wing to cool by radiation means that, when compared to a finned tube battery, X-Wing can deliver 40% more cooling without any additional risk of draft.

The efficiency of the convection process, coupled with the ability of the product to exchange energy by way of long - wave radiation, means that X-Wing retains a high cooling effect even when the air temperature in the room is relatively low (e.g. at night or when the building is unoccupied). In this way large amounts of cold energy can be stored in the building structure during low load periods, and used to offset heat gains when the need arises.

At a glance

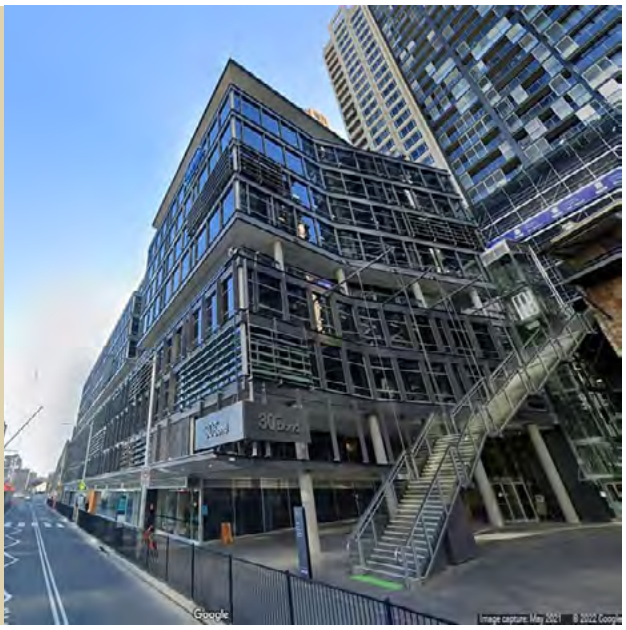
- **Shallow Depth unit (only 4 15⁄16")**.
- Only 1⁄4" clearance required behind unit and as little as 9 15⁄16" total ceiling construction (see page 8).
- Widths available 1' 3 3⁄4", 1' 9 5⁄16", 2' 2 13⁄16" and 2' 8 5⁄16".
- Lengths available 3' 11 3⁄16" up to 19' 8 3⁄16"in increments of 3 1⁄8".
- Can be installed exposed or ideal for "concealed" applications such as behind perforated metal ceilings or within architectural metal ceilings such for ceiling integration or freely suspended Multi Service Chilled Beams.
- **Eliminated risk of water leakage. No joints in the copper coil**, just one continuous serpentine for all product widths up to 13' 1 3⁄16" long and up to 19' 8" 3⁄16 long for up to 1' 9 5⁄8" wide models (only 2 joints for 2' 3" and 2' 8" wide models over 13' 1 3⁄16" in length).
- **Specialist black or white coating for smooth, long lasting, easy to clean, uniform finish that increase the radiant absorption coefficient for the product.**
- 40 percent more allowable passive cooling for X-Wing without increased draft risk, this is due to X-Wings "Radiant" quotient as compared to passive fin coil convective cooling products by others.
- Can be installed above light fittings with no loss of performance.
- Provides indoor climate in accordance with **BS EN ISO 7730 / ASHRAE 55.**

Development of X-Wing

Shell Centre - London - 1962

BT Leavensden Park - Watford - 2001

The Bond - Sydney - Australia - 2004



X-Wing delivers the best of both worlds

Static cooling systems (chilled ceilings and chilled beams) have, over the past 40 years, proven themselves capable of delivering high levels of occupancy comfort at reduced running costs. The FTF Group was at the vanguard of this technology when, in 1962, we supplied 1,900,000ft² of chilled ceilings to the Shell HQ building in London (Europe's first fully - sealed air conditioned building!).

Since this time the cooling requirements for a typical office environment have increased considerably; improved insulation, higher occupancy densities and a much higher usage of IT equipment have all fueled this increase, It became apparent in the mid 1990's that the cooling capacity of a traditional chilled ceiling was not sufficient to meet these increased heat gains, and consequently higher-capacity Passive Chilled Beam batteries were introduced into perimeter zones to offset the solar load generated at the building facade.

However, this mixture of systems was not without it's problems. The chilled ceiling part of the system requires careful co-ordination with a bespoke ceiling system, offers no flexibility to increase cooling capacity when office use changes (e.g. when creating meeting areas), is difficult to access for maintenance and carries a premium supply / install cost. Where finned tube batteries are used they are generally placed above metal ceilings with large perforation holes and with an excessive open area (typically 50% clear); requiring the "blacking out" of the ceiling void and resulting in an inconsistent ceiling aesthetic. The challenge was to provide a one-system solution that delivered the higher cooling capacity and lower cost of a chilled beam system, whilst maintaining the comfort and aesthetic advantages of chilled ceilings.

The introduction of "Radiant Chilled Beams" is arguably the perfect marriage of these two technologies; the beam delivers high cooling capacities (up to 49.6BTU / hr / ft²) and high comfort levels (lower air velocities and lower perceived temperature due to the radiant effect) in a package that can look no different to a contemporary high-spec ceiling system. All this at the substantially lower costs associated with chilled beam installations.

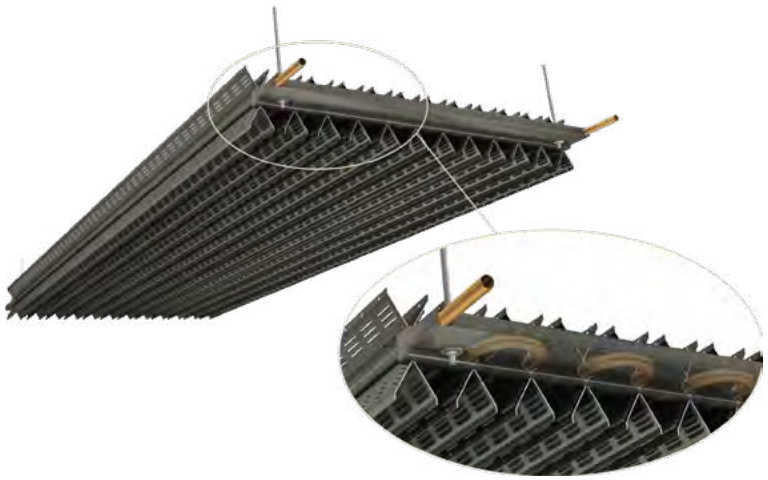
This natural progression for chilled ceilings has been employed successfully on many high - profile projects - from the 270,000ft² call center for BT in Watford to Bovis Lend Lease's HQ building in Sydney, Australia - and many other projects of note throughout Europe.

The FTF Group has further developed this chilled beam / chilled ceiling hybrid to incorporate an increased radiant surface area within a shallower depth and narrower width than ever before, for such levels of cooling (now even more cooling performance!).

Sinusoidal Copper Bending Machine

X-wing is manufactured from copper and aluminium and is 100% recyclable. The copper coil is produced by FTF Group's in house fully CNC automated "State of the art" serpentine bending machine which produces seamless sinusoidal copper coils (without any joints) up to 14ft in length, with up to 12 water passes at 2.8" tube centers from large drums of seamless copper tubing.

FTF Group's QMS (Quality Management System) is audited twice yearly by the BSI (British Standard Institute) to BS EN 9001:2015 and FTF Group are proud to confirm no reported leaks whatsoever from the hundreds of thousands of coils produced since the serpentine bend machine installed at FTF Group's Derby factory in 2010.



X-Wing CNC Tube Encapsulation Machines

Project Example - The International House, Sydney

Cooling Performance

Perforation Pattern	X Wing Output (Btu/h/ft/°F)			
	XW 400-15	XW 540-15	XW 680-15	XW 820-15
Exposed	10.2	13.9	17.8	19.9
7D/4D – 10X10 S	9.0	12.5	15.9	19.2
7D/4D – 7.07X7.07 ST	9.0	12.5	15.8	19.1
27X5 Diamond	8.9	12.3	15.6	18.7
25x5 Slot	8.9	12.3	15.6	18.7
9D - 8.9X8.9 ST	8.8	12.2	15.4	18.4
9D - 12.6x12.6 S	8.8	12.2	15.4	18.4
7D - 14X14 ST	8.8	12.1	15.3	18.3
7D - 10X10 S	8.8	12.1	15.3	18.3
4D - 10X10 ST	8.2	11.0	13.6	16.1

Example: XW820-15 6ft long with 9D - 8.9X8.9 ST perforated metal ceiling based on CWF/R = 57/62.5°F, and an average room condition of 24°C.

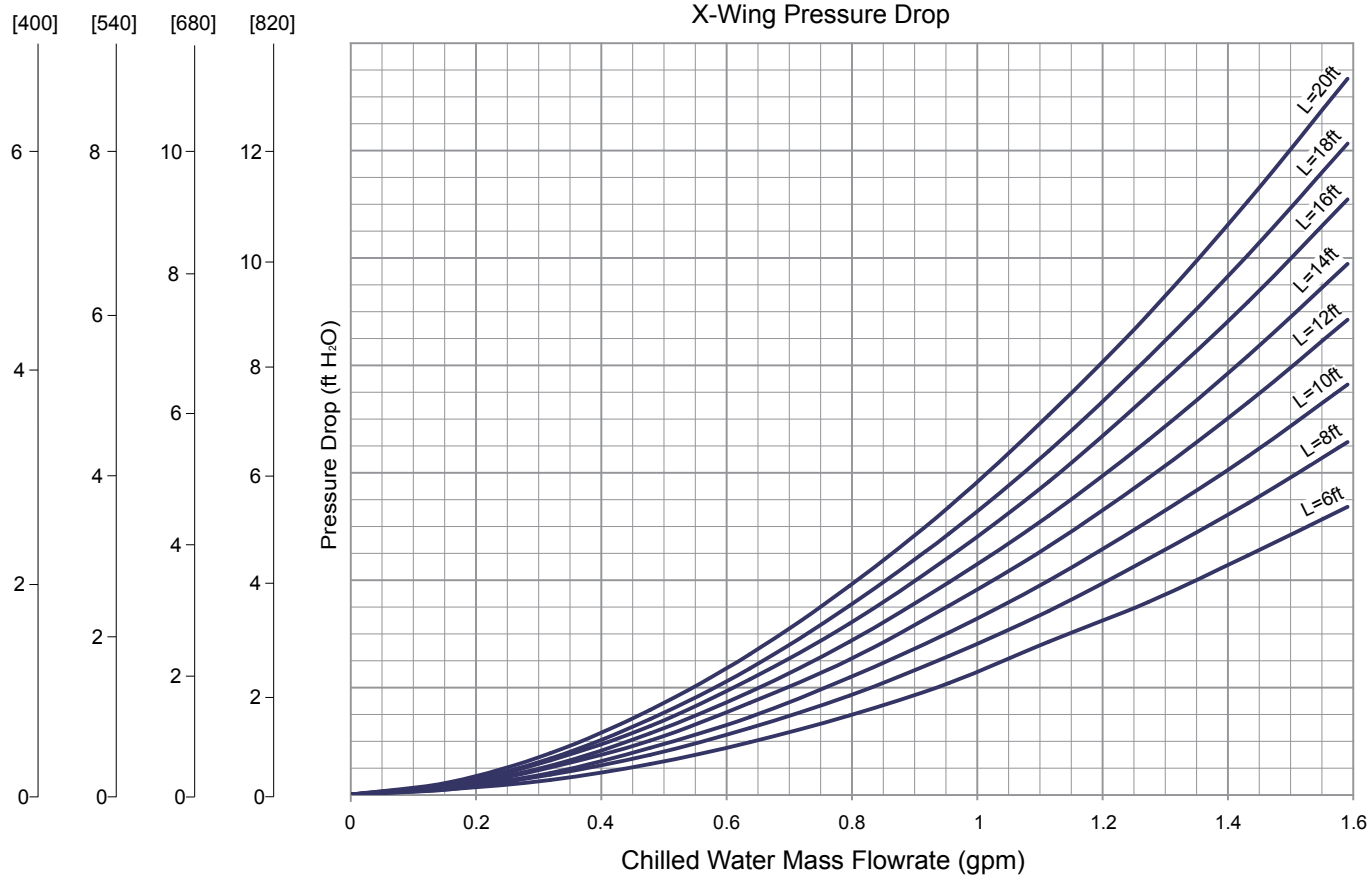
From Table X-Wing Output = 18.4 Btu/h/ft/°F.

Therefore: °F = 75.2 – [(57+62.5)/2] = 15.45°F, so X-Wing nominal cooling performance = 18.4 x 15.45 x 6 = **759W**

X-Wing Nominal Output (W/m/K) where K = Temperature Difference Between Room Average Temperature and Mean Water Temperature (dTK).

We recommend use of our Eurovent approved calculators for more accurate sizing (see page 19), given calculation tools, make allowance for performance changes associated with changes in heat transfer coefficients due to the specific chilled water mass flowrates. Please contact sales@ftfgroup.us to request access to the calculator.

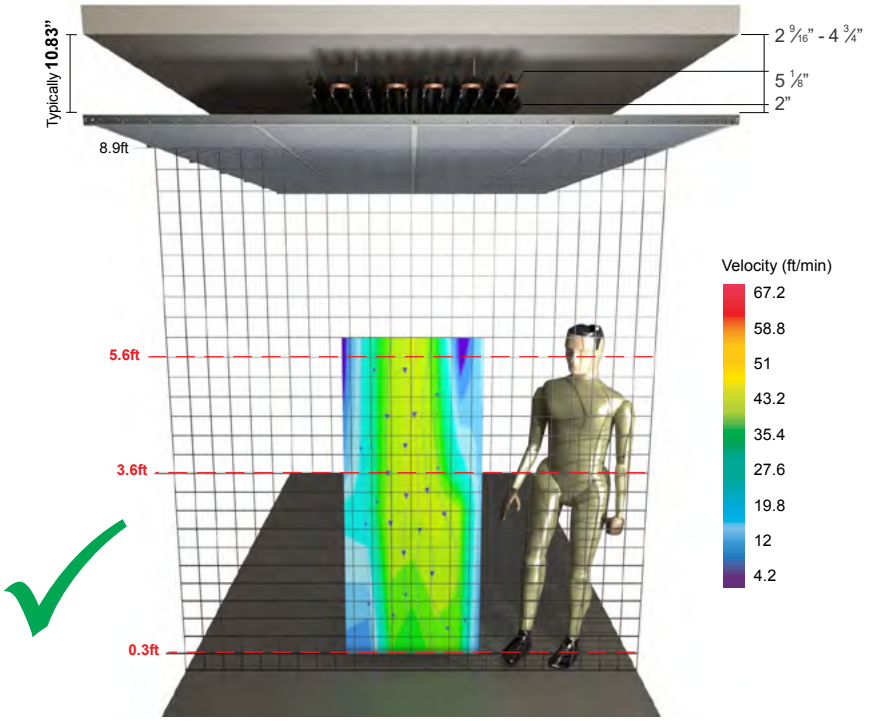
Pressure Drop



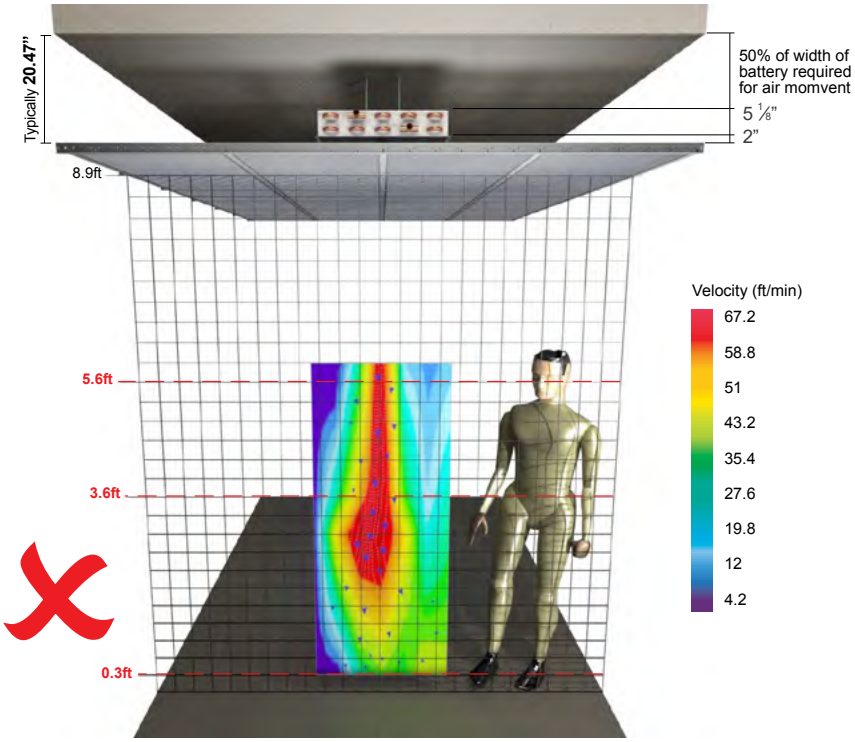
Increased Occupancy Comfort

The following Climatic Test Report color Topography below shows comfortable air velocities directly below the X-Wing radiant convective beam achieving 285.6 BTU/hr/ft as opposed to a convective only fin-coil battery also performing 285.6 BTU/hr/ft.

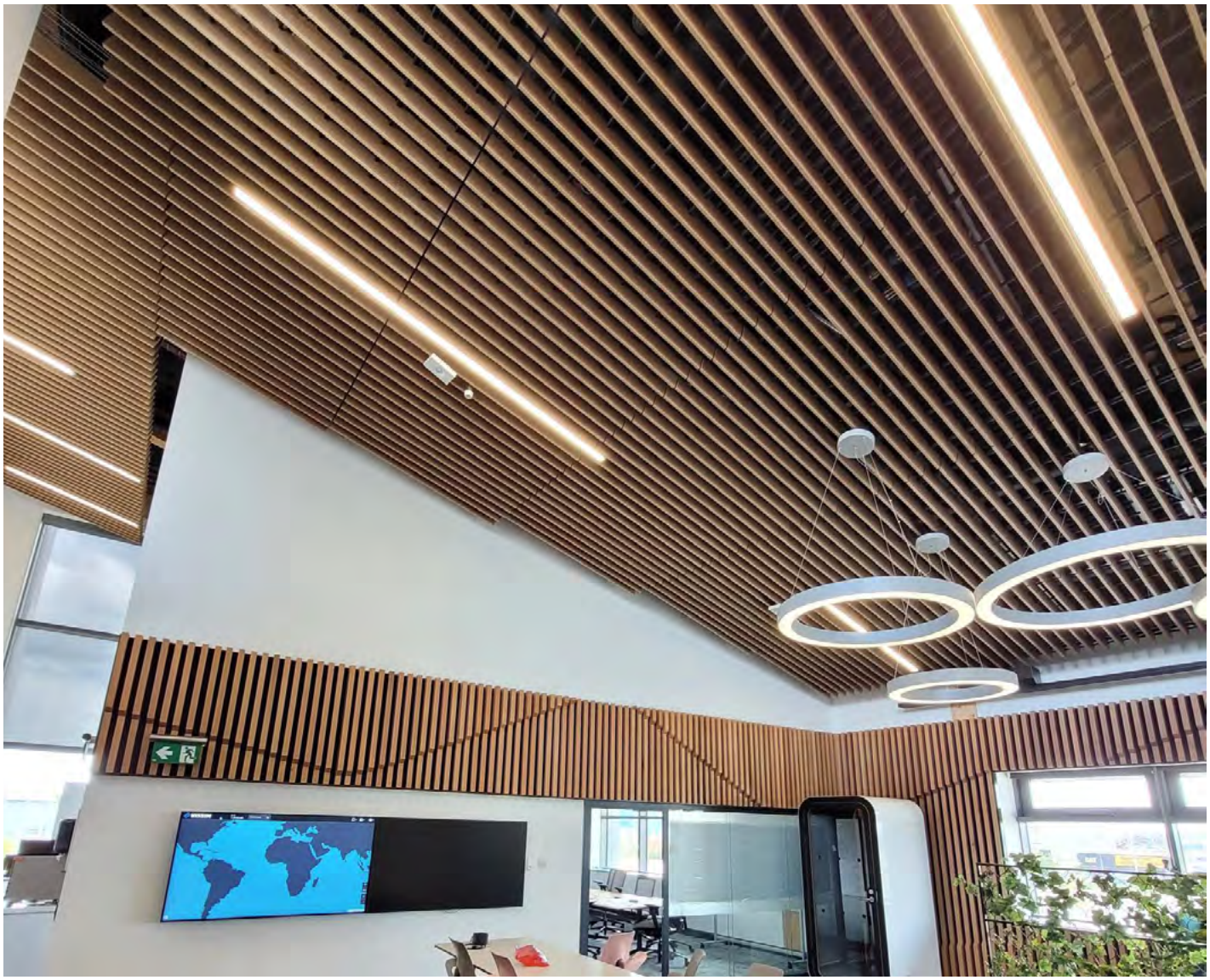
X-Wing (Radiant Chilled Beam)



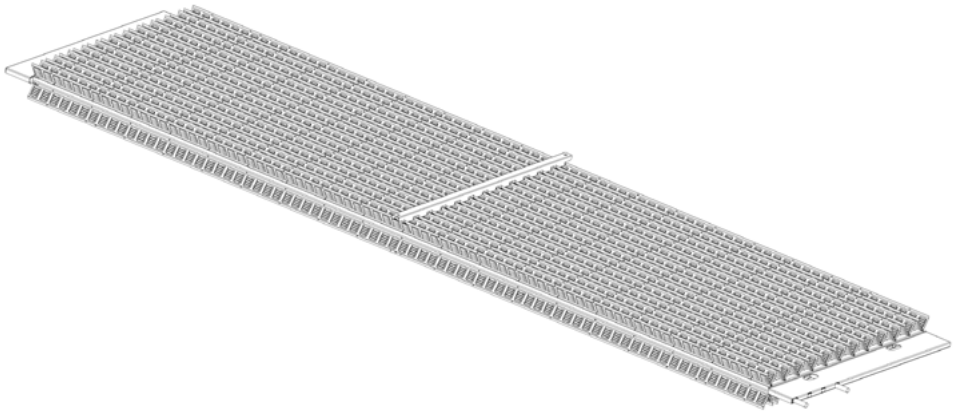
Fin-Coil Battery (Convective only Chilled Beam)

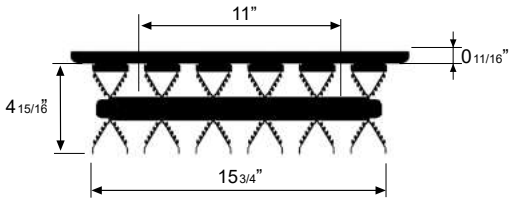


Project Example - Dogger Bank O&M Base

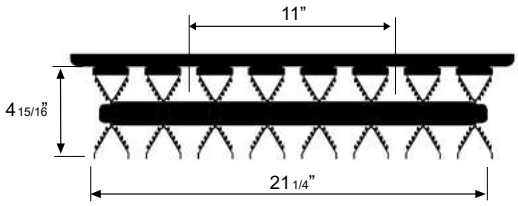


Product Dimensions

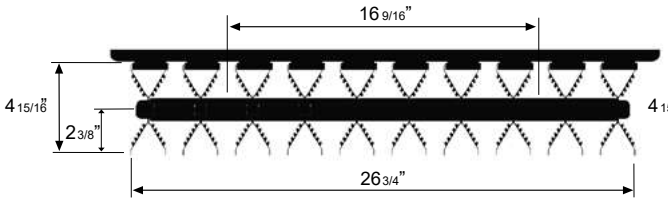




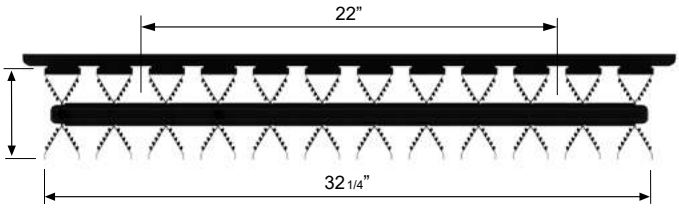
XW 400-15



XW 540-15



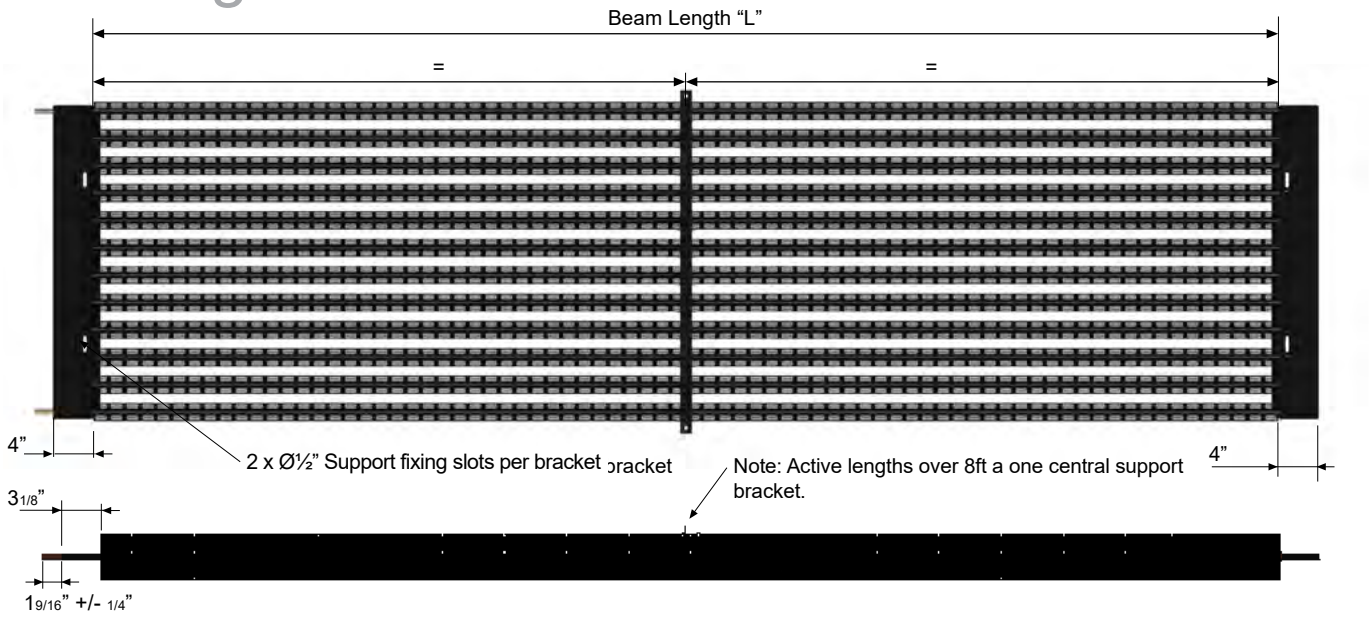
XW 680-15



XW 820-15

* Note all dimensions are ± 0 3/4”

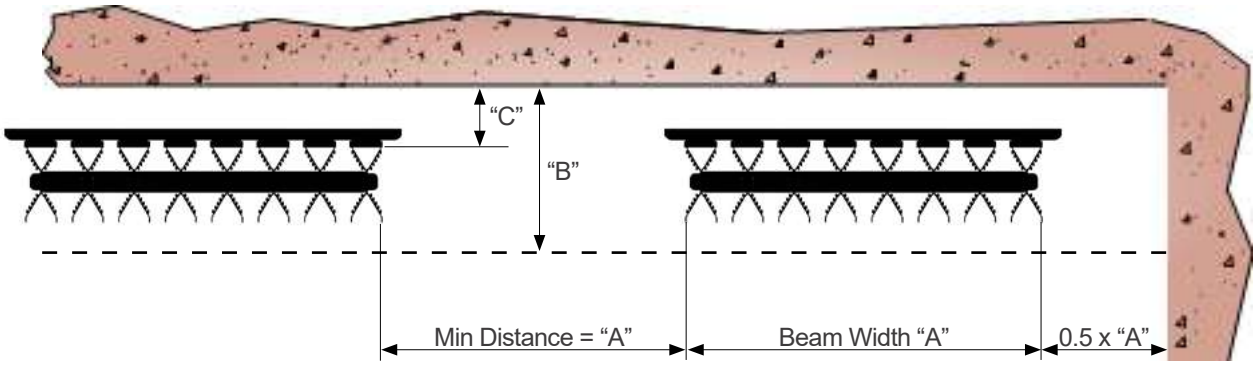
Mounting Details



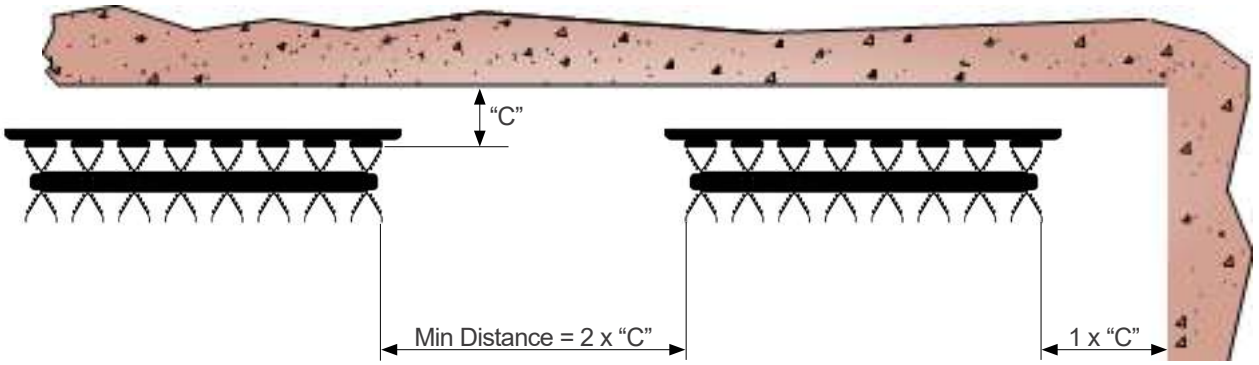
Weight & Water Content

Model Ref.	XW 400-15	XW 540-15	XW680-15	XW820-15
Dry Weight (lb/ft)	3.6	4.8	6.0	7.1
Water Content (US Gal/ft)	00.8	0.10	0.13	0.15

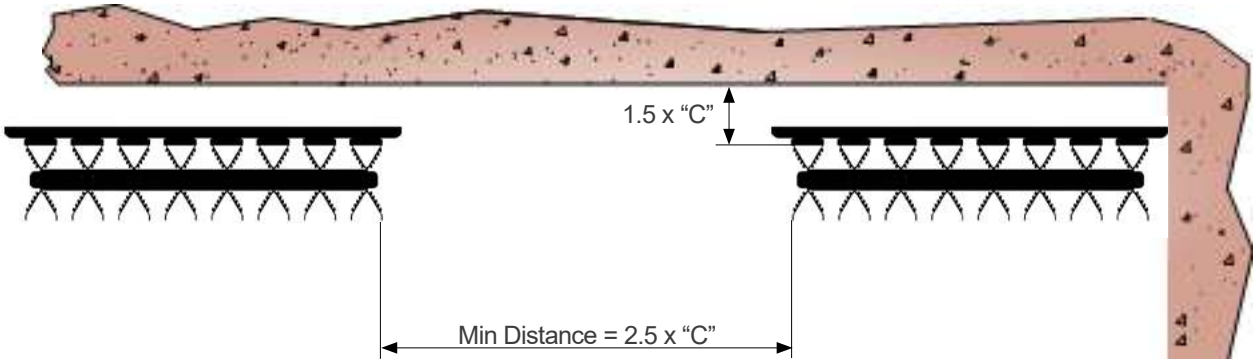
Product Positioning



XW Above Perforated Ceiling



XW Exposed

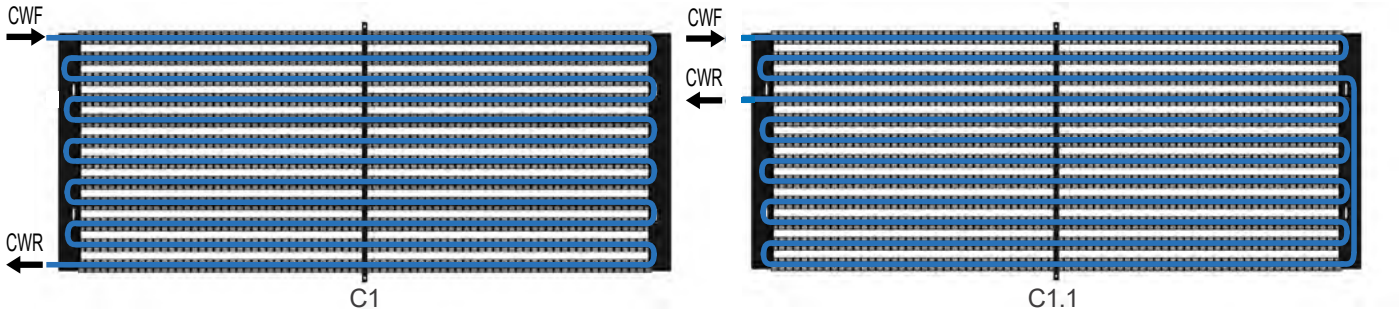


XW Exposed

Model Ref.	Dim "B"	Dim "C"
XW 400-15	9 15/16"	2 9/16"
XW 540-15	10 1/2"	3 1/8"
XW 680-15	11 7/8"	3 15/16"
XW 820-15	12 11/16"	4 3/4"

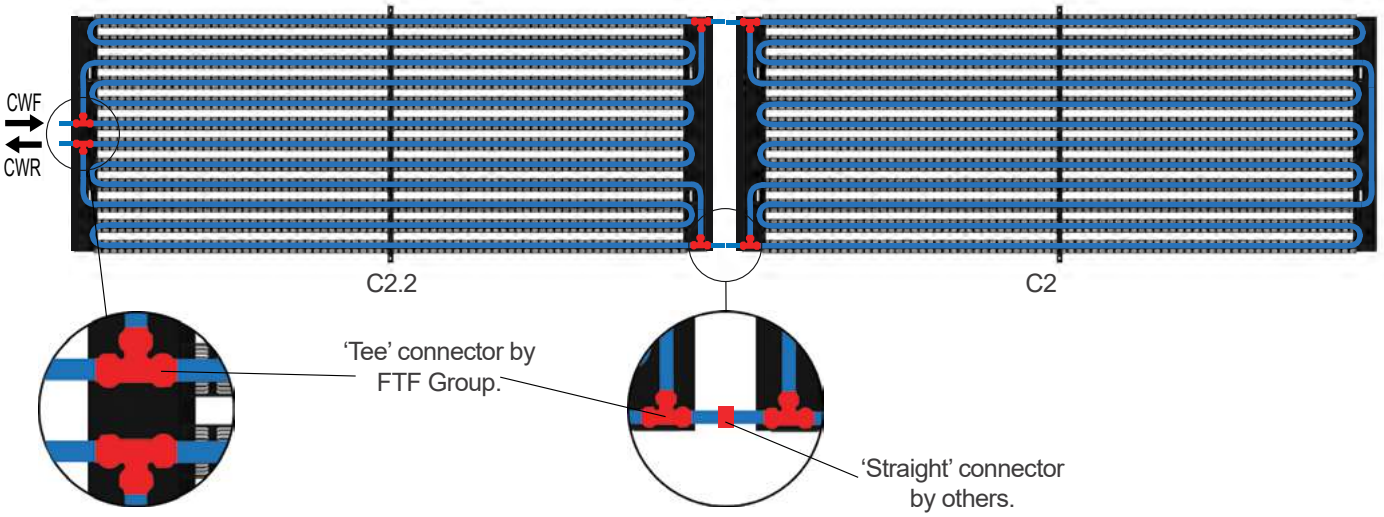
Circuit Details

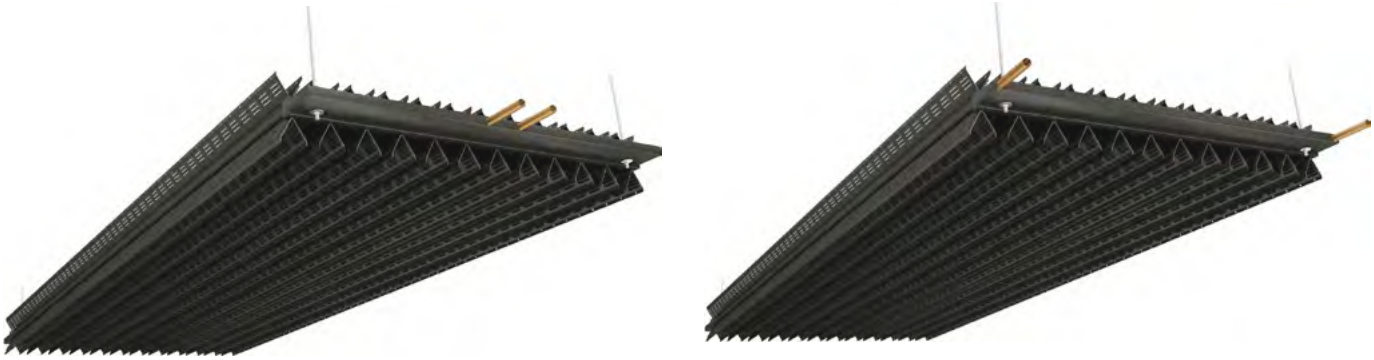
X-Wing 820 Manifold Type C1 and C1.1



Type C1 and is the standard X-Wing and is good for all single beam lengths upto 15ft, anything over 15ft C2 can be used.

X-Wing 820 Manifold Type C2 and C2.2



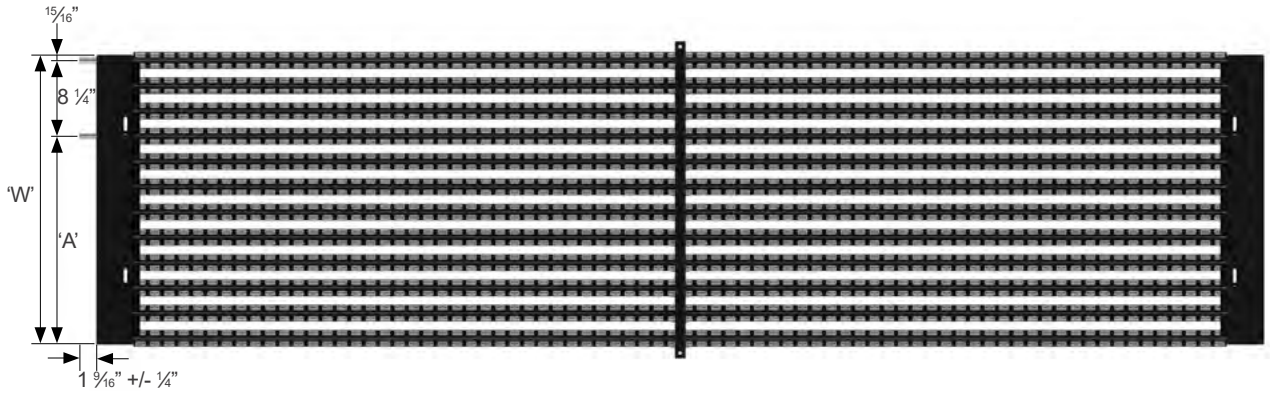


Type C2 manifold is 'Special' and can be used for parallel circuits for high mass flowrates only.

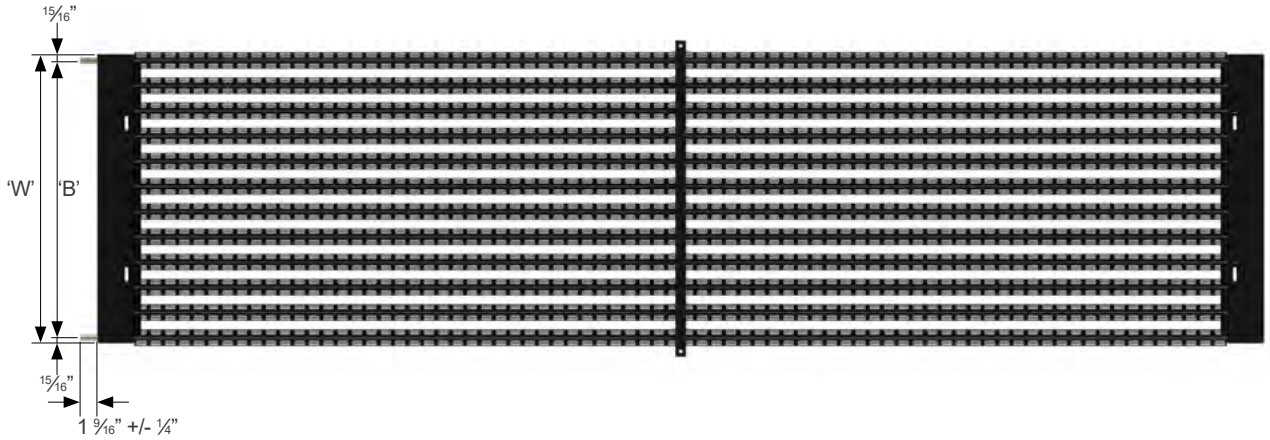
X-Wing 820 Type C1 Maximum Mass Flowrate based on a 10.1ftH_20 maximum pressure drop **				
Nominal Active Length (in)	<141 ¾"	165 ⅜"	189"	212 9/16"
Maximum Mass Flowrate (gpm)	1.632*	1.601	1.506	1.426

Note:
* Maximum mass flowrate limited to ensure tubeside velocity is less than 3.3 ft / s.
** Although not normally required the X-Wing unit can be specially supplied with either C2 or C2.2 manifold enabling higher mass flowrates and connection in series; however these options should be selected on an as needed basis given the C2 and C2.2 X-Wing units would have a longer lead time than C1, increased cost and introduction of internal tee connections within the manifold.

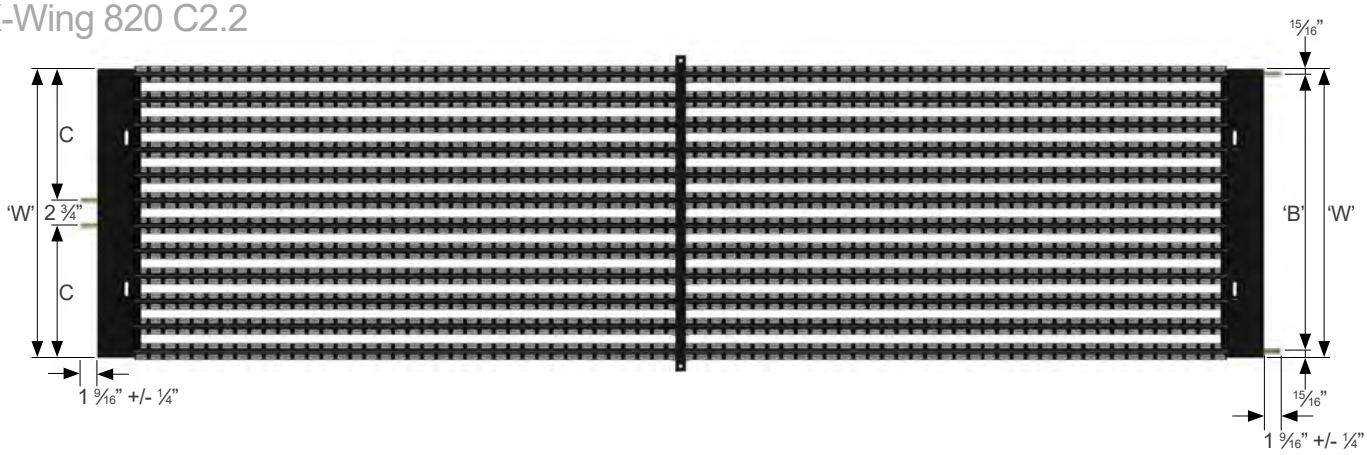
X-Wing 820 C1.1



X-Wing 820 C1 and C2



X-Wing 820 C2.2



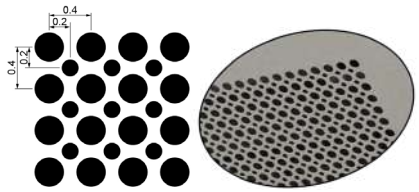
Model Ref.	Width 'W'	Dim 'A'	Dim 'B'	Dim 'C'
XW 400-15	15 ¾"	7 ½"	11"	6 ½"
XW 540-15	21 ¼"	13"	19 ¼"	9 ¼"
XW 680-15	26 ¾"	18 ½"	24 ¾"	12"
XW 820-15	32 ¼"	24"	30 ¼"	14 ¾"

All dimensions ± ⅛"

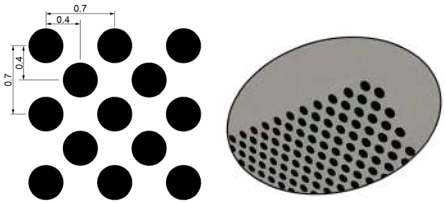
Project Example - UIUC Siebel Centre

Perforation Pattern Options

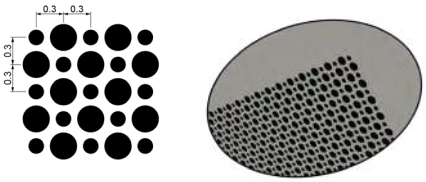
7D/4D – 10X10 S
51% Open Area



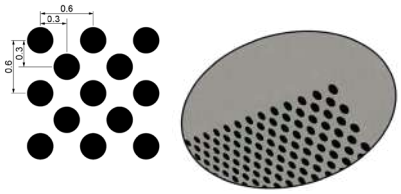
9D - 8.9X8.9 ST
40% Open Area



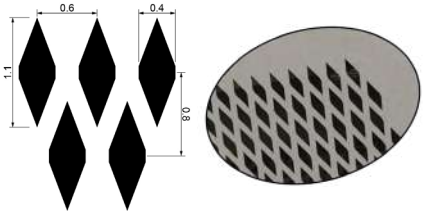
7D/4D – 7.07X7.07 ST
49% Open Area



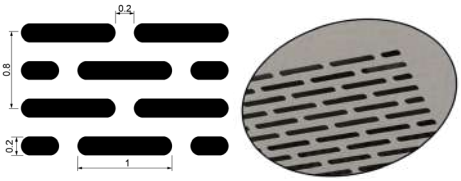
7D - 14X14 ST
39% Open Area



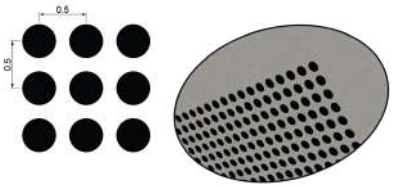
27X5 Diamond
43% Open Area



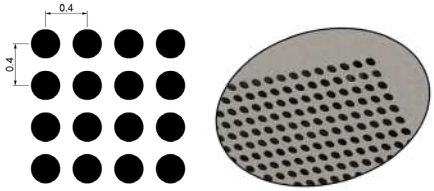
25x5 Slot
43% Open Area



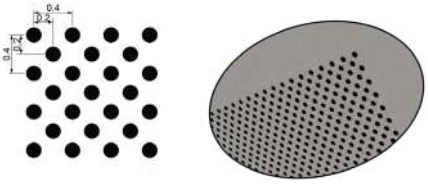
9D - 12.6X12.6 S
40% Open Area



7D - 10X10 S
39% Open Area

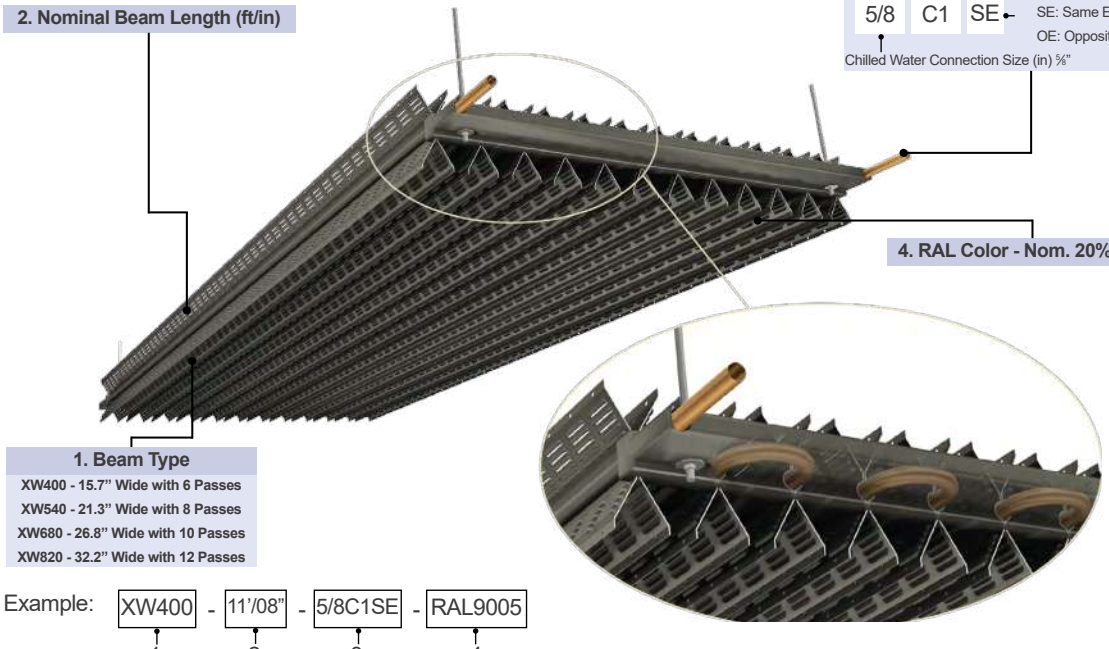


4D - 10X10 ST
25% Open Area



The perforations above are available for FTF Group's PCB and MSCB casings. Alternative perforation patterns can be utilised for ceiling systems (provided by others) with concealed X-Wing units above, please consult our technical services department for further advice. Dimensions in inches.

Product Ordering Codes



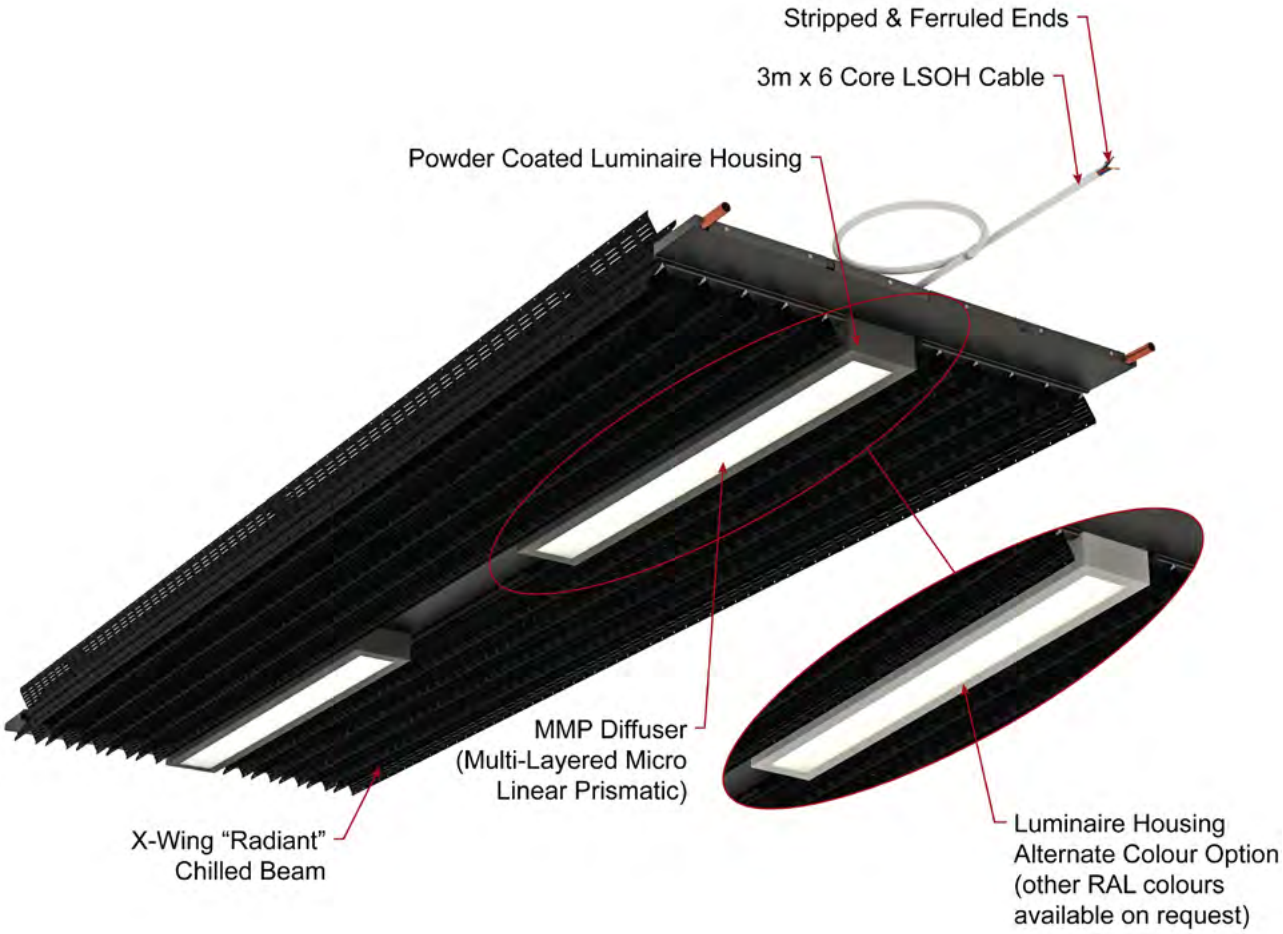
Example: XW400 - 11'/08" - 5/8C1SE - RAL9005
1 2 3 4

MSCB and PCB Casings

Riverside House - Ofcom - Passive MSCB

1 Lancaster Circus, Birmingham - Passive PCB and MSCB units

X-Wing Light



Due to unique design of FTF Group's X-Wing, it can accommodate easy integration of a variety of light fittings. The luminaires can either be free issued to FTF Group, whose expert lighting designers will develop a method to best incorporate the light fitting into the X-Wing, or one of FTF Group's bespoke in-house designed LED solutions can be utilised.

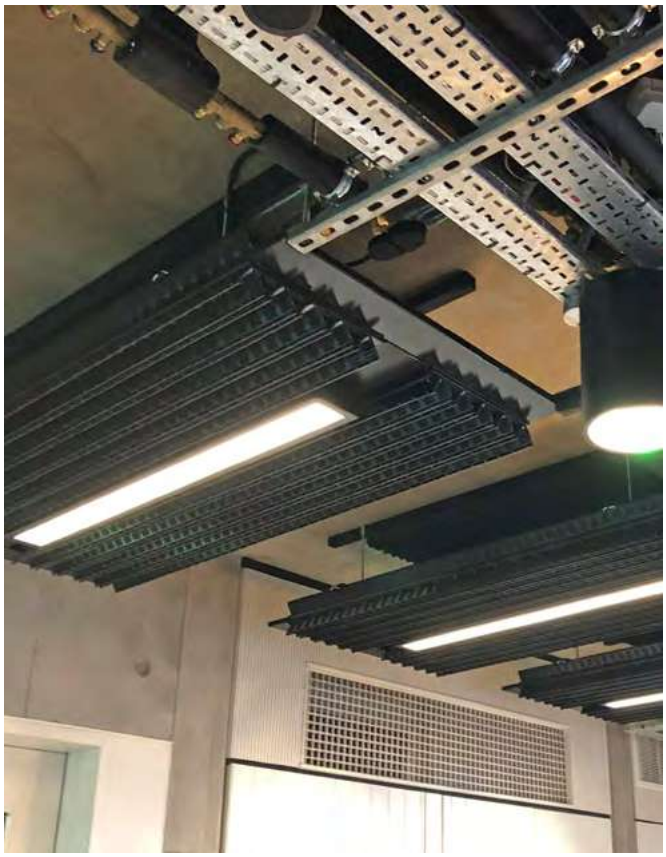
The LED lighting solution incorporates Philips Zhaga compliant LED lighting which has been extensively tested and developed in conjunction with the X-Wing chilled beams to enable active cooling of the LED boards to achieve greater life expectancy. Philips provide a 5-Year return to base Warranty for the LED Boards and the Drivers and emergency Invertors (lithium batteries 1 year) from date of delivery to FTF Group. The LED boards utilised are low voltage and are totally integrated within the luminaire housing.

Optics

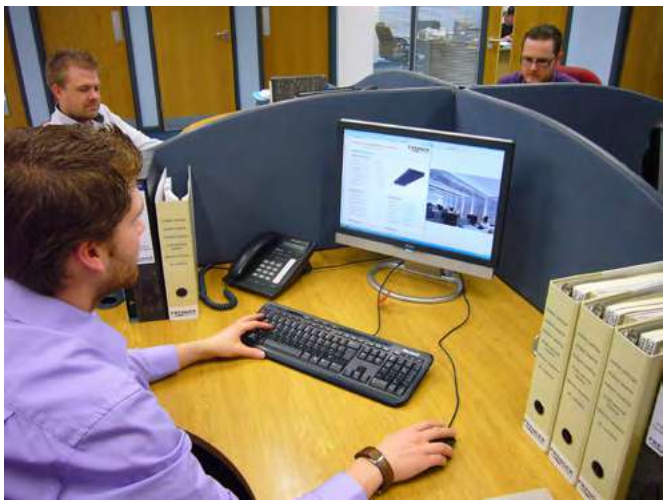
- State-of-the-art PHILIPS LED (Zhaga Compliant) modules.
- Direct lighting via Multi-Layered Micro-Linear or Diamond Prismatic Diffuser.
- Optional indirect lighting via clear polycarbonate.
- Long lifetime: >50,000 hrs all LED boards and Drivers have a Philips 5 Years return to base Warranty.
- LED Colour Temperatures: 3000K, 4000K, 5000K and 6500K.
- Colour Rendering Index: Min 80.
- Excellent colour consistency SDCM 3
- Wide temperature (Tc) range from -40°F to +185°C.
- Lumen Maintenance Test Results According to IESNA LM-80 = L80B10 (>70,000 hrs)
- ESD Withstand Voltage: Up to 8kV direct contact.
- Optional Emergency conversion.
- All components LED's, Drivers, Terminals are 1st Tier manufacture.
- LED Drivers are DALI as standard*.

Drivers can be supplied (upon request) as "Sensor Ready" with integral DALI 2.0 power supply and incorporate integrated energy metering for use in building management systems from the SR certified partner program. *(Energy metering accuracy + / - 4%)

Project Example - Riverside House - Salford



Calculation Program



X-Wing Selection Data

System Type	CICB	
Model Ref.	XW820	
Active Length	5' 3"	
Manifold Type	C1	
Perforation Hole Size	0.177	Inches
Perforation Free Area	30%	
Return Air Gap	4.72	Inches

The FTF Group's calculation program for X-Wing is extremely user friendly.

Simply select from the drop down menu the "system type". Select the model, manifold and perforation as per the particular project requirements.
The "return air gaps" is the clearance behind the X-Wing unit (see product dimensions page 8) to the underside of roof slab.

Design Conditions

Flow Water Temperature	57.0	°F
Return Water Temperature	64.5	°F
Air Supply Temperature	60.0	°F
Average Room Condition	75.0	°F
"Air On" Thermal Gradient	1.2	°F
Room Relative Humidity	50.0	%

Complete your project data in the "Design Conditions" section. Please note that the "Air On" Thermal Gradient can be used up to 33.8ºF for MSCB system types without the calculation program flagging up *"talk to the FTF Group's technical personnel"*, although we recommend that it is much safer to design to a worst case scenario and not to rely on a room temperature gradient.

Performance Data

Room - Mean Water dT	14.25	°F
Air On - Mean Water dT	15.45	°F
Waterside Performance	**1135**	**BTU/hr**
Water Mass Flowrate	0.301	gpm
Waterside Pressure Drop	0.2	ft H_20

"Performance Data" will then be automatically be calculated. Likewise "Dimensional Date" will be also automatically calculated. Finally, the "Design Check" should read "Ok" in green, or detail some warnings in red.

Calculation programs for X-Wing are available upon request.

Contact our technical department or complete an application request form on www.ftfgroup.us from the relevant link on our home page.

"Radiant" Chilled Beam (RPCB) Calculation Tool

FTF GROUP® Climate

Is this the latest version?

version 2.9.2

Project Ref.

X-Wing Selection Data

System Type	CICB	
Model Ref.	XW820	
Active Length	5' 3"	
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EUROVENT CERTIFIED PERFORMANCE

Design Conditions

Flow Water Temperature	57.0	°F
Return Water Temperature	64.5	°F
Air Supply Temperature	60.0	°F
Average Room Condition	75.0	°F
"Air On" Thermal Gradient	1.2	°F
Room Relative Humidity	50.0	%

Dimensional Data

Beam Depth	5.75"	
Beam Width	2' 8"	
~~O/A Beam Length~~	~~5' 10.9"~~	
CW Connection	Ø1/2-SE	
Water Volume	0.8	gal
Total Dry Weight	42.8	lb

Performance Data

Room - Mean Water dT	14.25	°F
Air On - Mean Water dT	15.45	°F
Waterside Performance	**1135**	**BTU/hr**
Water Mass Flowrate	0.301	gpm
Waterside Pressure Drop	0.2	ft H_20

Design Check

Cooling Circuit OK

Cooling Function OK

Model Ref: XW820-5' 3"-1/2C1SE-RAL9005

Notes:
1) Performance calculations are based upon normal clean potable water; it is the system engineer's responsibility to allow for any reduction in cooling or heating performance due to additives that may reduce the water systems heat transfer coefficient.

2) Pressure drop calculations are based upon CIBSE guides using clean potable water and exclude any additional losses associated with entry / exit losses, pipe fouling or changes in water quality; it is the system engineer's responsibility to use good engineering practice.

Bespoke Manufacturing

FTF Group has the manufacturing capability required to deliver the most complex of bespoke solutions. Facilities include the latest full CNC machine centers, together with a dedicated powder-coat paint plant to paint all of the components of the products and project specific in-house testing laboratories.

Project Specific Testing Facility

The FTF Group have 3 number state-of-the-art Climatic Testing Laboratories at one if its subsidiary companies predominantly situated at the prestigious Pride Park. Each laboratory has internal dimensions of 20.7ft x 18.7ft x 10.8ft high and includes a thermal wall so that both internal and perimeter zones can be simulated. Project specific testing validates product / solution performance (outputs) and resultant Room Comfort Conditions for compliance category grading in accordance with BS EN ISO 7730. All of FTF Group's chilled beams have also been independently tested and certified by Eurovent in terms of product performance (output), as Eurovent can not test for thermal comfort; hence the need for FTF Group's own laboratories.

Project Specific Testing

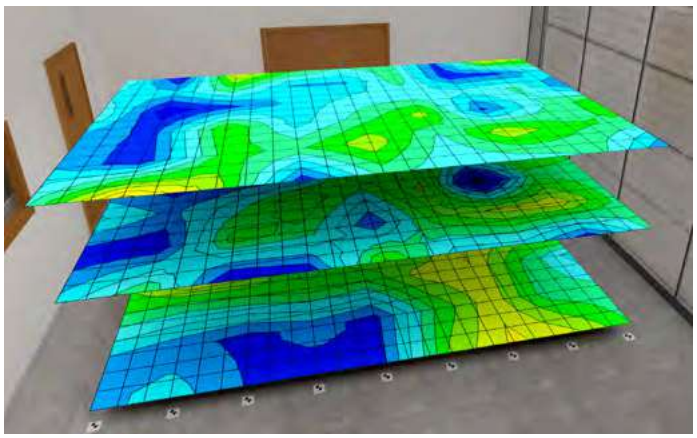
Project specific mock-up testing is a valuable tool which allows the Client to fully assess the proposed system and determine the resulting room occupancy Thermal Comfort conditions. The physical modelling is achieved by installing a full scale representation of a building zone complete with internal & external heat gains (Lighting, Small Power, Occupancy & Solar Gains).

The installed mock-up enables the client to verify the following:

- Product performance under project specific conditions.
- Spatial air temperature distribution.
- Spatial air velocities.
- Experience thermal comfort.
- Project specific aesthetics.
- Experience lighting levels (where relevant).
- Investigate the specific design and allow the system to be optimised.

The project-specific installation and test is normally conducted to verify:

- Product capacity under design conditions.
- Comfort levels - air temperature distribution.
  - thermal stratification.
  - draft risk.
  - radiant temperature analysis.
- Smoke test video illustrating air movement.
- Live Thermal Imaging



Photometric Testing Facility

The in-house Photometric test laboratories at FTF Group's Technical Facility are used to evaluate the performance of luminaires. To measure the performance, it is necessary to obtain values of light intensity distribution from the luminaire. These light intensity distributions are used to mathematically model the lighting distribution envelope of a particular luminaire. This distribution along with the luminaires efficacy allows for the generation of a digital distribution that is the basis of the usual industry standard electronic file format. In order to assess the efficacy of the luminaire it is a requirement to compare the performance of the luminaire against either a calibrated light source for absolute output or against the "bare" light source for a relative performance ratio.

The industry uses both methods. Generally absolute lumen outputs are used for solid state lighting sources and relative lighting output ratios (LOR) are used for the more traditional sources. Where the LOR method is chosen then published Lamp manufacturer's data is used to calculate actual lighting levels in a scheme and for LED light source the integration chamber is used to measure LED luminance efficacy.

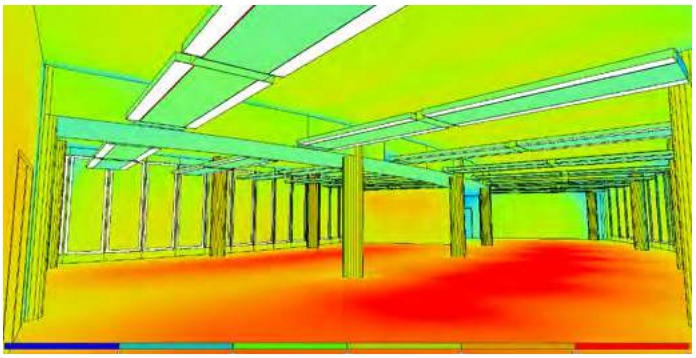
The intensity distribution is obtained by the use of a Goniophotometer to measure the intensity of light emitted from the surface of the fitting at pre-determined angles. The light intensity is measured using either a photometer with a corrective spectral response filter to match the CIE standard observer curves or our spectrometer for LED sources.

Luminaire outputs are measured using our integrating sphere for smaller luminaires or our large integrator room for large fittings and Multi Service Chilled Beams. For both methods we can use traceable calibrated radiant flux standards for absolute comparisons.

All tests use appropriate equipment to measure and control the characteristics of the luminaire and include air temperature measurements, luminaire supply voltage, luminaire current and power. Thermal characteristics of luminaire components can be recorded during the testing process as required.

A full test report is compiled and supplied in "locked" PDF format. Data is collected and correlated using applicable software and is presented electronically to suit, usually in Eulumdat, CIBSE TM14 or IESN standard file format.

FTF Group conduct photometric tests in accordance with CIE 127:2007 and BS EN 13032-1 and sound engineering practice as applicable. During the course of these tests suitable temperature measurements of parts of LED's can be recorded. These recorded and plotted temperature distributions can be used to provide feedback and help optimise the light output of solid state light source based luminaires which are often found to be sensitive to junction temperatures.



Acoustic Testing Facility

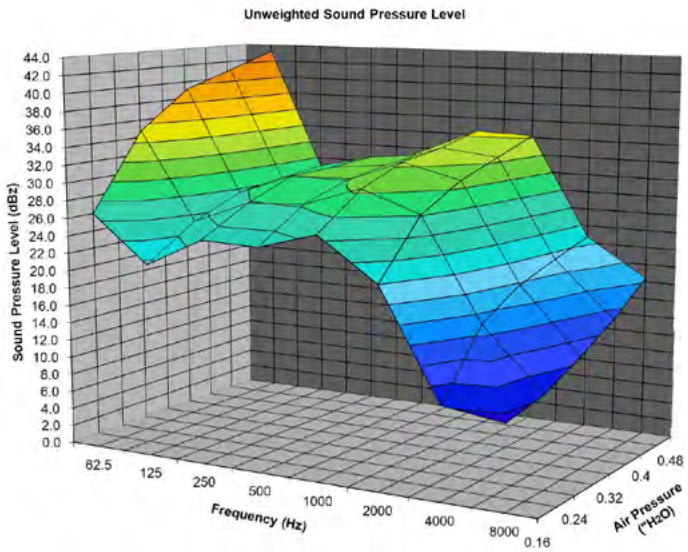
The Acoustic Test Room at FTF Group's Technical Facility is a hemi-anechoic chamber which utilises sound absorbing acoustic foam material in the shape of wedges to provide an echo free zone for acoustic measurements; the height of the acoustic foam wedge has a direct relationship with the maximum absorption frequency, hence FTF Group had the acoustic wedges specifically designed to optimise the sound absorption at the peak frequency normally found with our active chilled beam products.

The use of acoustic absorbing material within the test room provides the simulation of a quiet open space without "reflections" which helps to ensure sound measurements from the sound source are accurate, in addition the acoustic material also helps reduce external noise entering the test room meaning that relatively low levels of sound can be accurately measured.

The acoustic facilities allows FTF Group to provide express in-house sound evaluation so that all products, even project specific designs can be quickly and easily assessed and optimised.

To ensure accuracy, FTF Group only use Class 1 measurement equipment which allows sound level measurements to be taken at 11 different ⅓ octave bands between 16 Hz to 16 kHz, with A, C and Z (un-weighted) simultaneous weightings.

In addition to the above, FTF Group also send their new products to specialist third party Acoustic Testing. The results of which are very close and within measurement tolerances to that of FTF Group's in-house measurement of sound.



Frenger Systems (trading as FTF Group Climate) participates in the ECC program for Chilled Beams. Check ongoing validity of certificate: www.eurovent-certification.com or www.certiflash.com

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