

the future of space conditioning

Carat

operations &
maintenance

V2.4



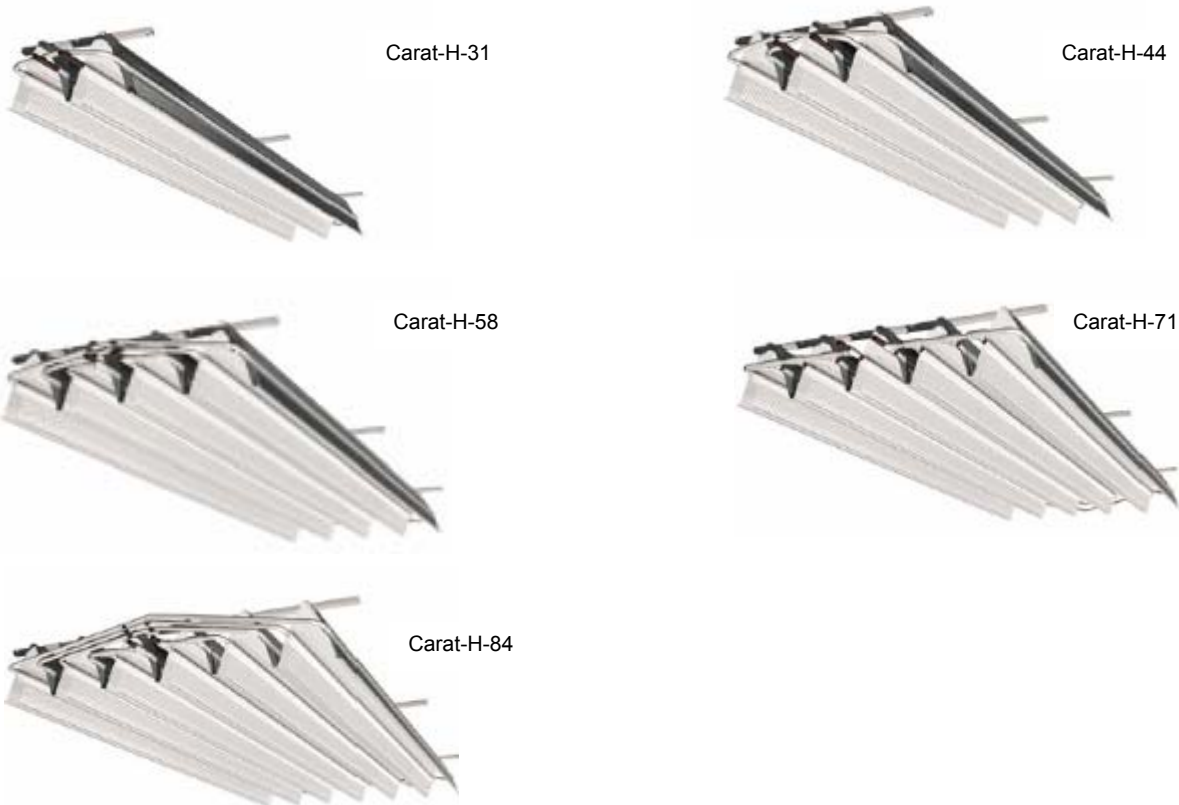
1.0 Description

Frenger's Carat chilled beam represents the very latest development in passive beam technology. Carat employs convective and radiant cooling principles and is designed to deliver high cooling duties (up to 140w/m²) with no noise and minimal air movement.

Carat can be installed above a perforated metal ceiling system, integrated into a multiservice chilled beam or suspended independently from the soffits. It is ideal for use in high-spec offices where there is a requirement to provide the best possible occupancy comfort levels with minimal environmental impact. Carat achieves this whilst integrating into aesthetically stunning ceiling systems or chilled beam casings.

The following guidelines are intended to assist the installer, and should not obviate good working practices.

There are five different models of Carat-H available; 31, 44, 58, 71 and 84



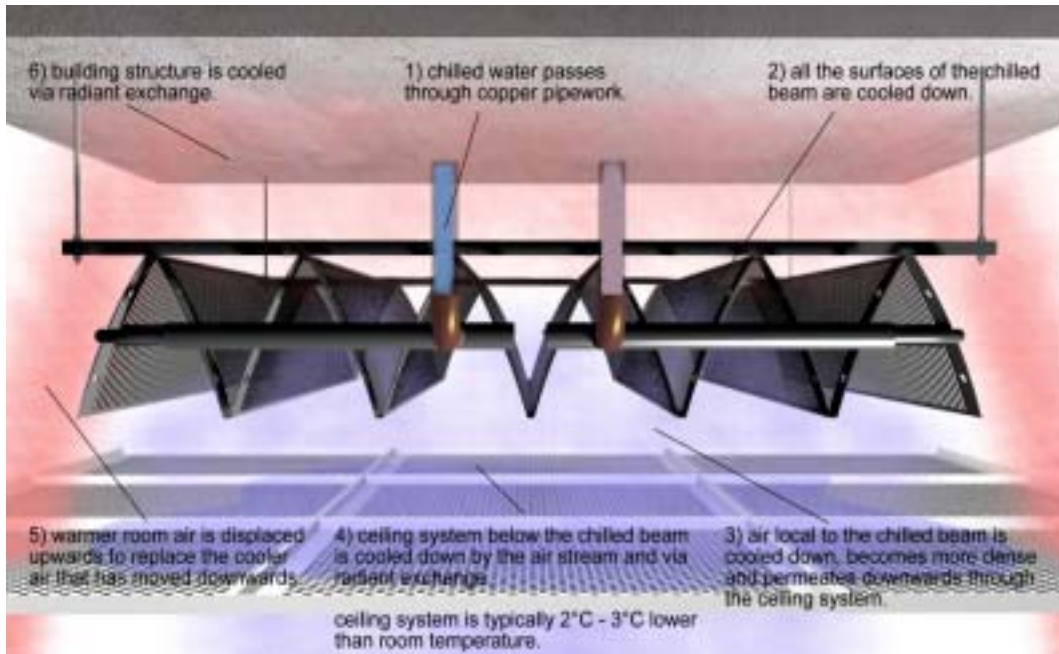
1.1 System Operation

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 its higher density, then streams through the punched louvres in the beam and percolates through the small ceiling perforations into the room space below. 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 also absorb heat radiation from the building occupants and the warmer surrounding surfaces. Carat's radiation quotient is approximately 35% of the total cooling effect (the other 65% of cooling being generated by the convective cooling effect described above). The ability of Carat to cool by radiation means that, when compared to a finned tube battery, Carat can deliver 50% more cooling with no additional risk of drafts.

| | | | | |
|-------------------------|----------------------|----------------------|--------------------------|--------------------|
| Frenger Systems Limited | Page 1 of 13 | | Carat O&M V2.4 | |
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The efficiency of the convection process, coupled with the ability of the product to exchange energy by way of long-wave radiation, means that Carat 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.



2.0 Cooling Effect

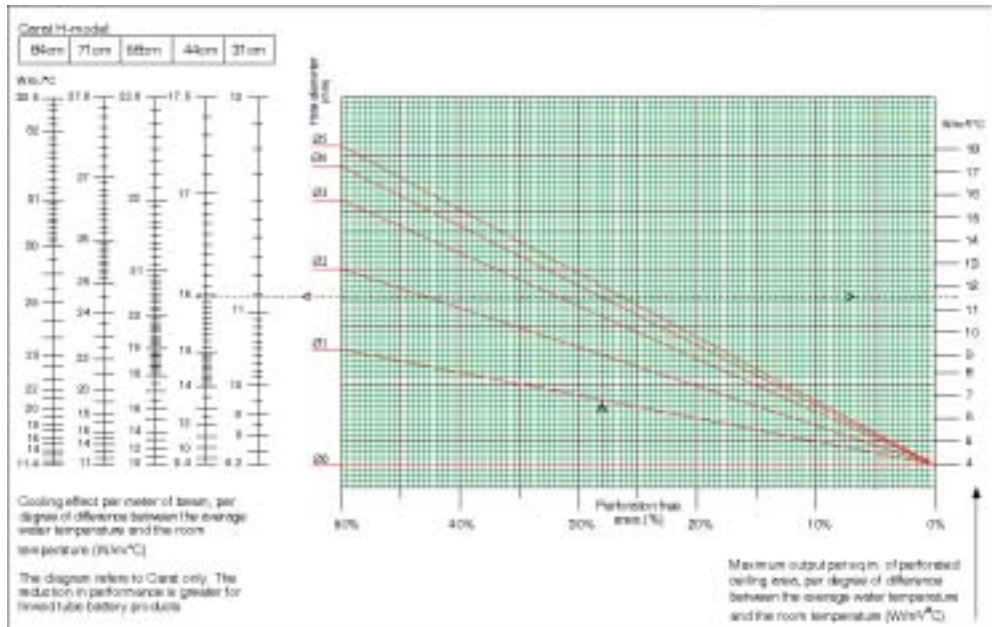


Diagram 1.

3.0 Suspension/Installation



Carat-H with threaded rod



Carat-H with adjustable hangers

Carat-H is suspended directly from the structural soffit using the chosen suspension system (for example, adjustable hangers or threaded rod). The looped hanger or threaded rod is fitted through the aluminium support bar (or through the suspension bracket where fitted). Four fixings are used for product lengths up to and including 3m (2 sets of 2); six fixings are used for products over 3m long (3 sets of 2). Please note that beams may be manufactured with additional support bars (e.g. a 3m beam may be manufactured with 3 bars instead of the 2 bars required for suspension). In these instances it is NOT NECESSARY to position hangers to all of the support bars as this may result in a short fall of hangers on the project.

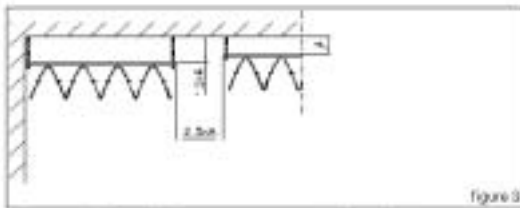
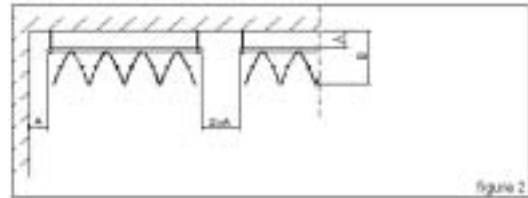
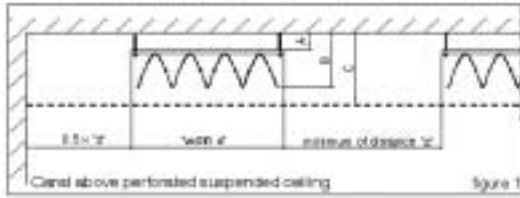
Measure the distance between the suspension points and mount the chosen fixing to the roof. Put adjustable hangers or threaded rod through the pre-drilled holes in the aluminium support bars / suspension brackets. Lift up the product using the hangers and attach the hangers/rods to the soffit fixing. DO NOT lift the chilled beam from any position other than the aluminium support bars or attached hangers. Adjust the beams vertical position according to the diagram on page 4. If necessary shorten the hangers/rods to appropriate lengths.

Hangers / rods should be secured to ensure that they do not come loose from either the soffit fixing or the chilled beam. Hangers should be secured by bending over the hanger end loops at either end, threaded rods by using 4 nuts for each rod - above and below the soffit fixing and again above and below the aluminium bar / bracket. Don't forget to tighten the nuts!

It is important to remember to fit the copper support sleeves into the water connection pipes before connecting the compression, press-fit or push-fit couplings. **NOTE! DO NOT SOLDER!** Ensure that allowance is made for possible expansion / contraction of the mains water pipework (using expansion loops or bellows). Where plastic connections or flexible hoses are used, it is important to ensure that these products are designed to be resistant to oxygen penetration. Ensure that the distribution pipework is flushed and cleaned in isolation of the chilled beam and that appropriate air vents are provided to remove excess oxygen from the pipework system.. Do not remove protective pipe caps until just before connection to the flushed distribution pipework.



In order for Carat-H to deliver the stated cooling capacity it is important to maintain specified distances from the structural soffit, walls and adjacent product.



Figures 1-3. Installation measurements for Carat.
Note: To achieve the low air velocities as per diagram 1, the distance between the beams should be at least 600mm.

| Model | A (mm) | B (mm) | C (mm) |
|------------|--------|--------|--------|
| Carat H-31 | 45 | 192 | 232 |
| Carat H-44 | 55 | 202 | 252 |
| Carat H-56 | 70 | 217 | 267 |
| Carat H-71 | 85 | 232 | 302 |
| Carat H-84 | 105 | 252 | 322 |

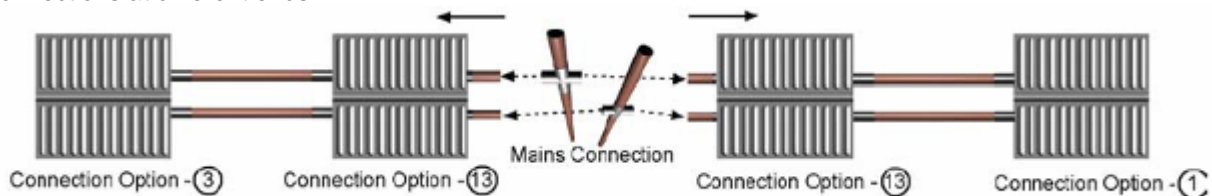
Minimum measurements for installation - see Figure 1-3



Diagram 2. Reduction of cooling effect when A measurement is reduced.

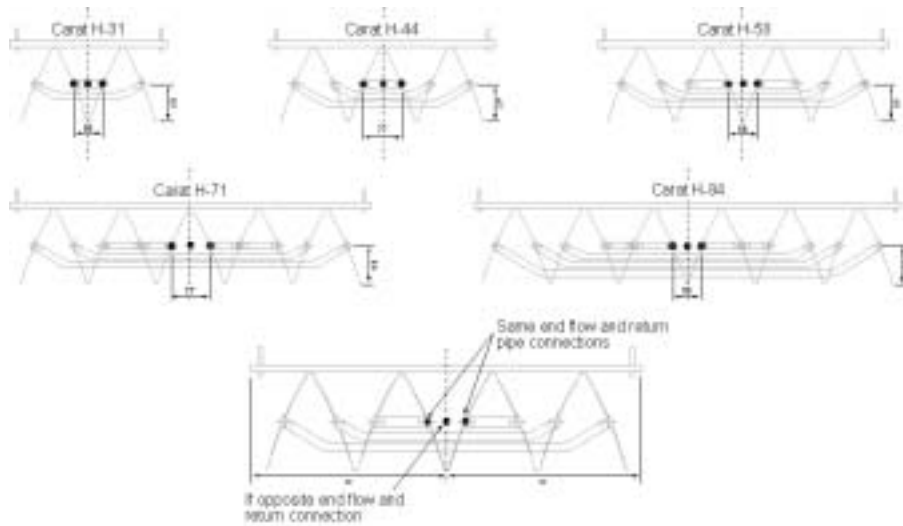
3.1 Exposed Installation

The free-hanging chilled beam appears slightly different when viewed from different directions – this is due to the directional nature of the punched cooling fins on the surface of the product. This difference of aesthetic should be considered when designing the connection position for each chilled beam. The diagram below illustrates that it is possible to have the cooling fins facing the same direction, but with horizontal pipe connections at different ends.



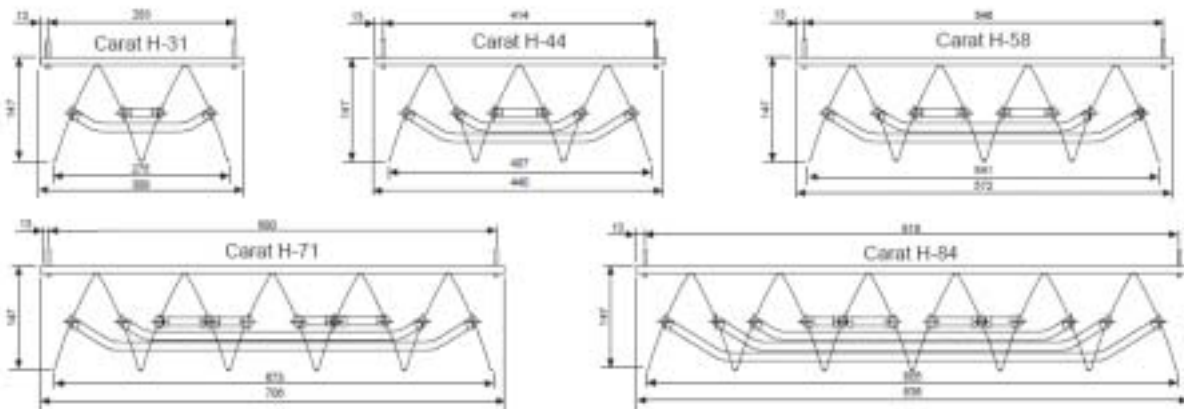
Please note that the Carat beam is a mechanical services item and consequently where the beams are left exposed we can not guarantee architectural standards of straightness or paint finish as may normally be expected for an internal finishing item. Extruded aluminium painted trim can be factory-fitted to the side bottom flanges of the beams to create a straighter aesthetic, available as an additional cost option.

4.0 Coupling & Connection

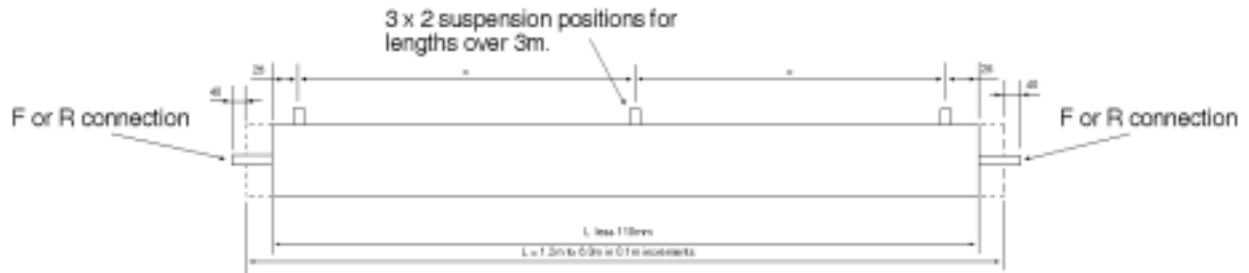


* Connection dimensions are subject to change without notice – if this information is critical then seek advice from Frenger’s Technical Department

4.1 Width & Height (mm)



4.2 Length

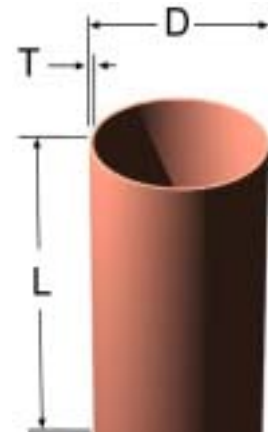


* Product Dimensions are subject to change without notice – if this information is critical then seek advice from Frenger’s Technical Department

5.0 Pipe Dimensioning

The copper pipe used to manufacture the Carat connections is compatible with the European Standard for Copper tubes EN1057; the dimensional specification is as follows:

The copper pipe material conforms to Swedish Standards SS5015-04 and SS5015-02, compatible with BS EN1057



| Manifold Type | 10 | 12 | 15 | 22 | 28 |
|--------------------------------|------|----|----|----|----|
| Connection Type, mm (D) | 10 | 12 | 15 | 22 | 28 |
| Wall thickness, mm (T) | 1 | 1 | 1 | 1 | 1 |
| Min. Straight Length, mm (L) | 35 | 35 | 35 | 35 | 35 |
| Min. Tube mass flow rate (m/s) | 0.28 | | | | |
| Max. Tube mass flow rate (m/s) | 1.00 | | | | |

6.0 Handling

NEVER handle the product from the extreme edges or from the pipe tails



ALWAYS handle the product from either the suspension bar, the pipe manifold or the bottom of the ‘A’ profile. Take care not to damage cooling fins or pipe tails.



7.0 Cleaning

The absence of any moving parts means that there is no requirement for periodic maintenance – only cleaning of the product surfaces. The Frenger Carat product is extremely easy to clean. This is done by periodically wiping the surfaces with a damp cloth, and we recommend that surface cleanliness is visually inspected every two years. The frequency of actual cleaning is dependant on the cleanliness of the environment; however the fact that there are no closely spaced fins (as in finned tube batteries) means that the time interval can be expected to exceed 3 years.



8.0 System Working Pressure

Carat has been designed and manufactured in accordance with the Pressure Equipment Directive 97/23/EC. The units are classified as SEP – Sound Engineering Practice and are manufactured and tested to the following pressures:

| | |
|-----------------------------------|------|
| Maximum working pressure, Bar (g) | 10 |
| Maximum test pressure, Bar (g) | 16.0 |

Where greater system pressures are likely to prevail on your project then please contact Frenger’s Technical Services Department for advice on how this could be accommodated when using Carat.

9.0 Water system and water quality

The chilled water and LTHW system should be filled using potable water which complies with the “EC Directive relating to the Quality of Water intended for Human Consumption 98/83/EC”; in area’s where the water is particularly “soft” with the PH towards the acidic side of neutral the water hardness must also be increased. Note hard waters may be softened to avoid excessive scale within the system however care must be taken as softened water is almost always more aggressive than raw water; should water softening be employed the minimum total hardness must be kept to a minimum of 60 ppm of CaCO₃.

The additional water specification requirements required for both the chilled water and lthw circuits above that of normal potable water (see above) are detailed in the following table:

| Variable | Acceptable Range / Maximum Concentration |
|-----------------|--|
| pH | 6-9 |
| Oxygen Content* | < 1 ml/l |
| Water Velocity | ≤ 1.0 m/s |

* Note: The Oxygen content must be kept stable at a value less than 1 ml/l as minor increases in Oxygen (e.g. an increase from 0.5 to 1 ml/l) will be detrimental to the system and therefore void any warranty.

Any additive inhibitors / chemical treatments to help reduce oxygen content, microbiological contamination, scaling and prevent corrosion must be appropriate to use with copper and solder. It must be noted that any water treatment must be maintained within the inhibitor manufacturers specified control parameters as excess inhibitors can be as detrimental as too little.

In order to ensure that the correct oxygen levels are maintained at the required level (less than 1 ml/l) without any increase and to ensure fouling due to debris does not occur within the chilled beam the following points should be noted:

- If plastic pipe is to be utilised on the installation the pipe must be manufactured with a 100% oxygen barrier (usually aluminium is bonded between the two walls of the plastic pipe).
- Expansion vessel membranes must be charged using nitrogen gas.
- In-line strainers must be used to remove particles from the chilled water and prevent debris from forming in the chilled beam.

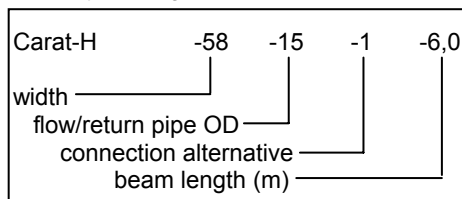
Note: Any debris/particulates that either encourage bacteria growth or cause restriction will invalidate the chilled beam warranty.

9.1 Water Evaluation

The customer should ensure that the correct water quality is maintained at all times; it is recommended that water quality is monitored and recorded bi weekly for the first 2 months of system start, then annually monitored and recorded subject to the water systems stability (all copies of water quality readings are to be forwarded to Frenger to keep on record).

10.0 Product Labelling

Delivery Coding



Beams are also supplied with support sleeves as standard, plus any optional items as specified in the documentation (special colour, suspension hangers, condensation sensors etc.).

11.0 Environmental product declaration

11.1 The Product

This environmental product declaration refers to Frenger System's Carat chilled beam. This product is manufactured at the company's manufacturing facility in Scandinavia.

11.2 Manufacturing

Carat is based on Frenger Systems strips. The strips consist of two aluminium strips, rolled together, with a copper pipe in between. The rolling procedure ensures that the aluminium is metallurgically joined to the copper pipe. The strips are then folded into a shape of serrated elements where all the surfaces are active. At the ends, copper connections are then soldered in place, selected for the correct pressure drop and flow (10, 12, 15 or 22 mm).

The product is powder coated in the colour requested. Finally, the product is packaged and delivered to the customer by truck.

| | | | | |
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11.3 Materials included in a 4-meter Carat H-31

| Material | Item | Detail | Weight | % of Total Weight |
|---------------|--------------------------|-----------------|---------------|-------------------|
| Aluminium | Strips | GA 5050-02 | 3.75 Kg | 55.1 % |
| | Cross brackets | SS 4104-06 | 0.36 Kg | 5.3 % |
| Copper | Strips | SS 5015-02 | 1.57 Kg | 23.1 % |
| | Connection pipes | SS5015-02 | 0.83 Kg | 12.2 % |
| Solder | Spelter solder (Sn97Ag3) | EN 29453 | < 1.5 g | |
| | Hard solder (Cu90Ag10) | | < 1.5 g | |
| Paint | Powder coated | Epoxy-polyester | 0.23 Kg | 3.4 % |
| Packaging | Pallet | Wood | | |
| | Cling wrap | Polyethylene | | |
| | Cellular plastic | | | |
| | Screws | Steel | < 40 g | 1.5 % |
| | Blind rivets | Aluminium | < 50 g | |
| | Annat | Aluminium | < 0.10 g | |
| Total: | | | 6.8 Kg | |

11.4 Use

Carat is used for spaces which require cooling. During operation, the product does not produce any demonstrable chemical emissions. Carat is maintenance free, apart from normal cleaning. The product has a technical life of at least 25 years.

11.5 Utilisation of Recycled Materials

Frenger adopts a responsible procurement policy whereby 20% of the steel and copper and more than 50% of the aluminium used in the construction of the product is already recycled. Therefore, more than **37%** of the finished product is derived from recycled sources. Furthermore, the company adopts a “smart” packaging policy that ensures that minimum amounts of plastic materials are used whilst ensuring product protection, and that all timber used in the construction of crates is derived from sustainable sources.

11.6 End-of-Life Recycling

At the end of the products’ useful life the company’s manufacturing facility accepts its own products in return, because nearly all of the materials can subsequently be recycled. Please contact Frenger Systems for instructions with regard to return transport and packaging

12.0 Packing, Offloading & Distribution

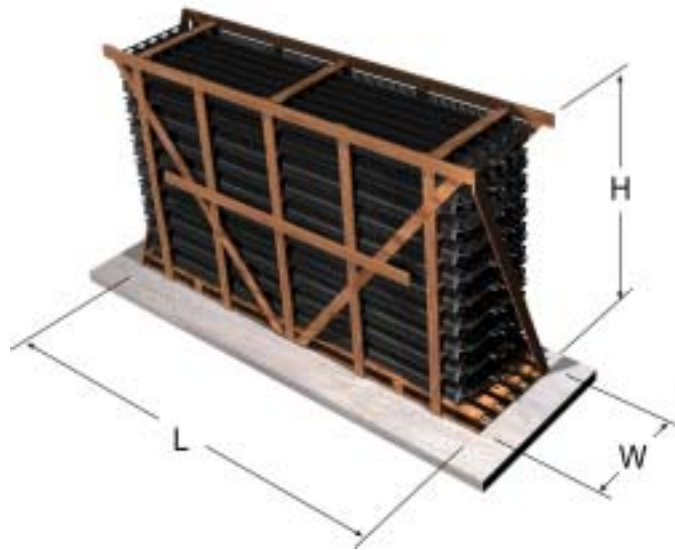
12.1 Packaging & Crating

Carat units are nested into pairs of similarly-sized product so as to reduce overall crate height. The pairs of product are then wrapped in low density polythene and packed into purpose-made wooden crates. The weight from the pairs of product is transferred directly to the wooden uprights of the crate (by use of wooden cross braces) such that there is no cumulative weight build-up. Polystyrene blocks are used to protect the product from the wooden cross braces and the finished crate is shrink-wrapped for additional integrity. The crates are suitable for lifting by pallet truck, fork truck and crane.

Where the product is delivered overseas then the wood used in the production of the crates is treated to the relevant standards.

12.2 Dimensions

| | |
|---|-------------------------|
| L | Longest product + 200mm |
| W | Widest product + 200mm |
| H | 2200mm (Maximum) |



12.3 Container Dimensions

Where Carat units are to be delivered overseas, they will be delivered using standard shipping containers. Approximate dimensions of such containers are detailed below:

| Container Size | Length (L) | | Width (W) | | Height (H) | |
|----------------|------------|----------|-----------|----------|------------|----------|
| | External | Internal | External | Internal | External | Internal |
| 20ft | 6.06m | 5.84m | 2.44m | 2.30m | 2.59m | 2.32m |
| 30ft | 9.12m | 8.90m | 2.44m | 2.30m | 2.59m | 2.32m |
| 40ft | 12.19m | 11.97m | 2.44m | 2.30m | 2.59m | 2.32m |





12.4 Quantities

| | |
|-------------------------------|-----------------|
| Carat 10, 12 or 15mm manifold | 21 Pieces/Crate |
| Carat 22mm manifold | 11 Pieces/Crate |

12.5 Weights (Dry)

| | |
|------------|----------|
| Carat H-58 | 3.3kg/m* |
| Carat H-71 | 4.5kg/m* |
| Carat H-84 | 5.0kg/m* |
| Crate | 13kg/m** |

* Dry weight

** Approximate

Example: A crate carrying 3m long Carat H-84 with 15mm manifold will be stacked 21-pieces high and the crate dimensions will be 3150mm (L) x 990mm (W) x 2200 (H). The product will weigh 315kg in total and the crate will weigh approximately 39 kg equating to a combined weight of approximately 354 Kg

12.6 Unloading Containers

Crates carried inside shipping containers are only accessible from the rear doors. The linear nature of the crates means that it is usual for the product to be presented end-on when the doors are opened. When the container arrives on site - and assuming that the containers are not being dropped to the floor - it is recommended that a temporary suitably robust loading-out platform be constructed by others to assist the offloading process. After ensuring that **the crates are not fixed to the floor of the container** a rope or sling should be passed through the bottom of the crate in a secure position so that the crate can be dragged gently to the back of the container using a fork truck (step 1). The crate should be lifted onto the loading-out platform using a fork truck (step 2) so that it can then be carried off using a fork truck at the side of the crate (step 3) or via a crane (ensuring that spacer bars are used to prevent the slings damaging the crate/product). Where containers are dropped to the floor then the process can be carried out without the use of the loading-out platform.



Step 1



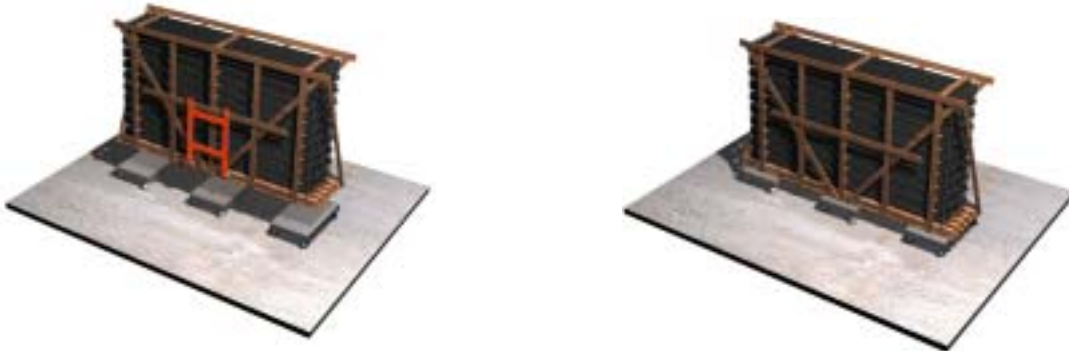
Step2



Step 3

12.7 Distribution on Site

Pallets should be distributed around site using sufficiently robust wheeled trolleys - one at each end and one in the centre of the crate. The crates should be lifted onto the trolleys using a fork truck. Of course the floor on site should be checked to ensure that it is secure, level, safe and free from obstructions and holes before the crates are transported on wheeled trolleys.



It is the responsibility of those persons carrying out the offloading and site distribution process to ensure that all relevant Health and Safety protocols are adhered to and that appropriate Personal Protective Equipment is employed by operatives.

12.8 Container Packing

Whilst each overseas shipment is being loaded photographs are taken of each pallet inside and outside of the container.

These photographs are then incorporated into a container checklist which details project/contact number, customer, order reference, the pallet number, the contents of each pallet and a picture showing the pallet before being loaded into the container and once loaded into the container.

The checklist will also detail that the pallets have been checked for quality and that leak test certificates are available



| Packing Information / Checklist | | | | FRENGER [®] systems | | | |
|---------------------------------|------------------------------------|---|----------------------------------|---|--|--------------------|-----------|
| Project Number: | | George Street | | Container 2 | | | |
| Our Contract Number: | | 102726 | | | | | |
| Customer Order Number: | | 10540 | | | | | |
| Pallet # | Quantity / Description | Check for Quality, Paint Colour, Quantity (✓) | Leak Test Certificates Available | Photographic Evidence Unloaded | Photographic Evidence Loaded | Person Responsible | Signature |
| 7 | 21 pcs - 4.5m long Carat H-64-15-1 | Yes | Yes |  |  | S-1 | |
| 8 | 21 pcs - 4.5m long Carat H-64-15-1 | Yes | Yes |  |  | S-1 | |

12.8 Notification of transit damage

In the unlikely event that the goods have suffered from obvious transit damage then Frenger should be notified of the occurrence in writing within 24 hours of receipt of goods and if goods are damaged or incorrect at the time of delivery then a note to this effect should be included when signing the delivery paperwork. The notification should include container number, pallet number and the quantity of products effected and should be accompanied by photographic evidence.

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