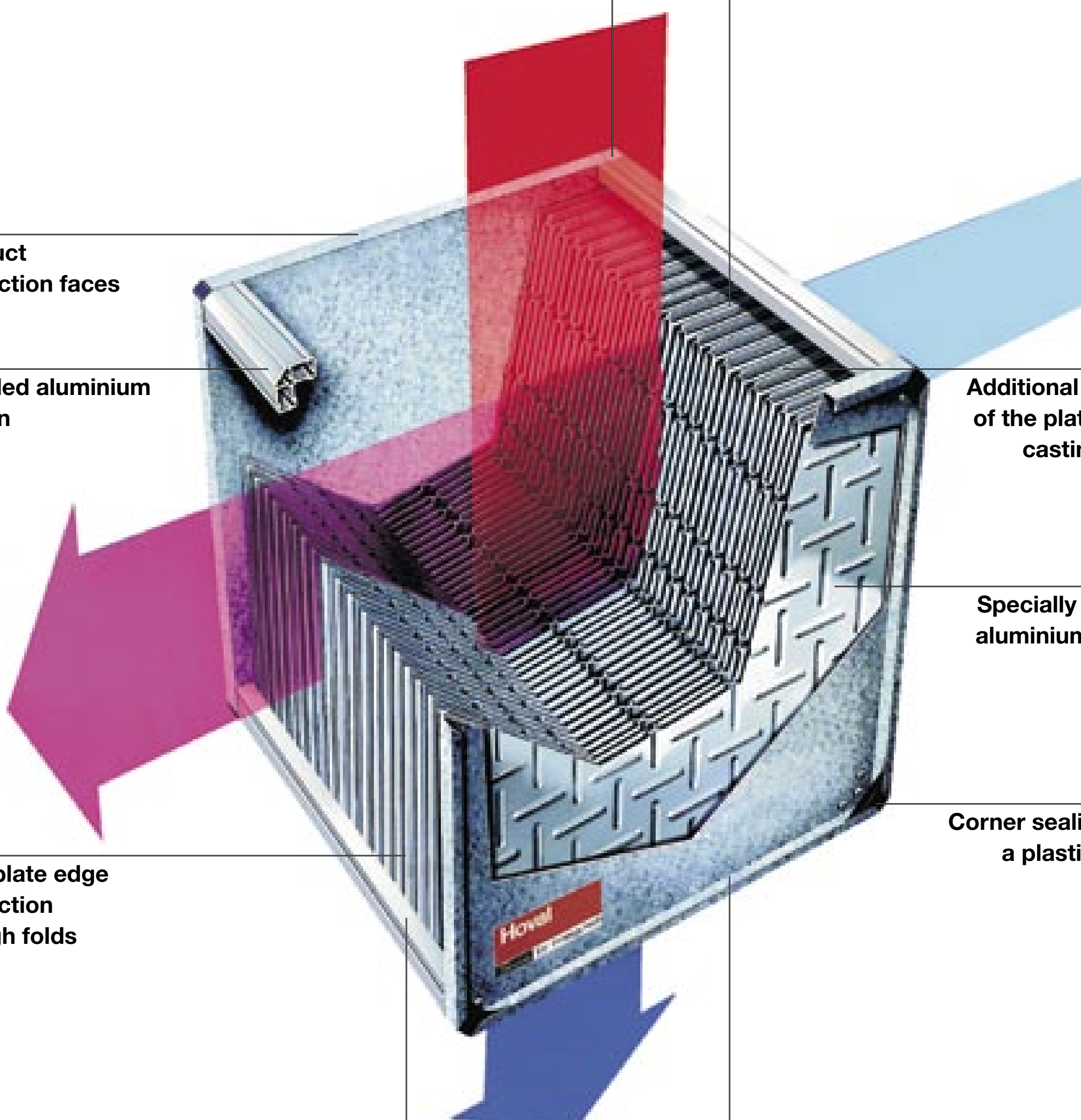
AH Series Air Handling Units with Heat Core, Heating Water Coil, Cooling Water Coil, Supply & Exhaust Air

HOVAL SERIES
Plate Heat Exchangers for Recovery in Ventilation Systems

Cut-Away View of Design N



At a Glance

Heat recovery reduces costs and protects the environment

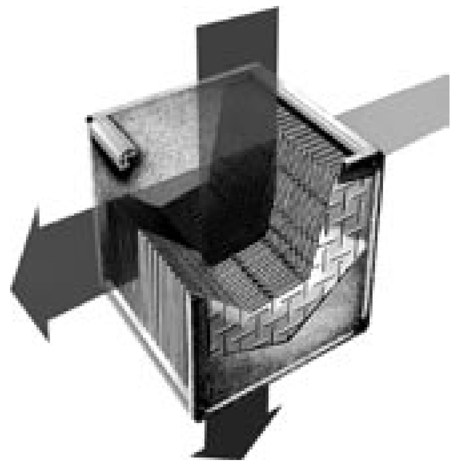
Hoval series plate heat exchangers are important elements in saving energy in industry, commerce, hotels, hospitals, sports halls, office buildings, seminar rooms, swimming pools, drying processes, paint spray booths, extraction plants etc. They are used in air handling units, ductwork systems and in process technology. This investment pays off in several ways:

- Lower energy consumption
- Lower investment for heat generation and distribution
- Less damage to the environment

No cross-contamination of the air streams

In the Hoval series plate heat exchanger the warm extract air and the cool fresh air, separated by thin plates, pass each other in cross-flow. No mixing of the two air streams takes place. Therefore, the transmission of dirt, odours, moisture, bacteria, etc. is impossible. Heat is transmitted from extract air to fresh air purely by conduction as a result of the temperature difference between the two air streams. The warm extract air is cooled down, the cool fresh air is heated.

Design N
Mostly used for ventilation of occupied area ex: office, school, mall center,hospital...



Wide variety of sizes available

Hoval series plate heat exchangers are available in a wide range of sizes to suit every application:

- Exchanger lengths from 23.6 to 66.9 inches (0.6 to 1.7 metres)
- Individual core from 3.9 to 118.1 inches (0.1 to 3 metres) height

The individual plate exchanger can be supplied with different plate spacings and heat recovery efficiencies.

At a Glance

Materials which suit the applications

Three series are available to suit a wide variety of applications:

- Standard series V: with the exchanger package of aluminium, the casing of aluminium extrusions and Galvanized sheet steel
- Corrosion-protected series G: where the exchanger package and the casing are coated
- High-temperature series T: with a special sealing agent resistant to temperatures up to 200 °C

Reliable in operation

Hoval series plate heat exchangers have no moving parts. Their function requires no electrical connection. There are therefore no extra running costs and operation is always guaranteed: 100 % reliability.
Many years of operation in numerous applications have proved that Hoval series plate heat exchangers are extraordinarily resistant to dirt build-up. Therefore no special maintenance is required.

Reliable data

Hoval series plate heat exchangers are independently tested time and again. The technical data are based on these test results. The Innergytech computer calculation program Winnergy allows easy and quick selection of the optimum plate heat exchanger for every application.

ARI PERFORMANCE CERTIFIED™
ARI Standard 1060

Energy recovery component certified to the ARI air-to-air Energy Recovery Ventilation Equipment Certification Program in accordance with ARI standard 1060-2005. Actual performance in packaged equipment may vary.

Hoval series plate heat exchangers offer many advantages

- High heat recovery effectiveness → low investment costs
- No moving parts → no wear, always ready for operation
- Separate air streams → no cross-contamination
- No electrical connections → no extra running costs
- Three series, a wide variety of sizes and plate spacings, any desired width → the optimum solution for every application
- Lightweight, compact design → easy to install
- Automated production → constant high quality

1 Principle and Operation

Hoval series plate heat exchangers operate within the guidelines for heat recovery as recuperators with joint faces. The heat releasing and heat absorbing air streams pass along the joint face, through which the heat is directly transmitted. Supply and extract air must therefore be brought together and flow through the heat exchanger.

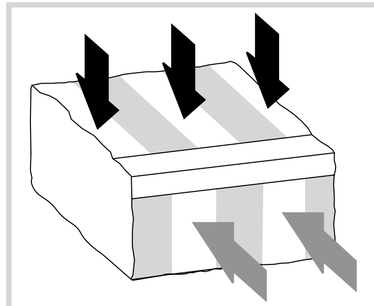


Fig. 1-1: Separated by the plates, the air streams pass each other.

1.1 Heat transmission

Hoval series plate heat exchangers operate on the cross-flow principle. Heat is transmitted via the plates from the warm to the cold air stream. A much simplified performance calculation is:

$$Q = k \cdot A \cdot \Delta t$$

When temperatures are given, the transmitted heat performance is assumed by design characteristics.

■ Heat transfer rate: The k-value is calculated from the thickness and heat conductivity of the plates, as well as heat transfer on both sides:

$$\frac{1}{k} = \frac{1}{\alpha_1} + \frac{d}{\lambda} + \frac{1}{\alpha_2}$$

As thin plates are used, for cost reasons, the influence of the material can be neglected. This is shown in table 1–1:

Material	Thickness [mm]	λ [W/mK]	$\alpha_1 = \alpha_2$ [W/m²K]	k [W/m²K]
Aluminium	0.125	200	40	19.9998
Aluminium	0.500	200	40	19.9990
Plastic	0.500	0.20	40	19.0476

Table 1-1: Plate thickness and material have only a slight effect on the effectiveness.

For good heat transmission, the heat transfer α must be high on both sides of the plates. For this reason Hoval optimised the plate profiles by extensive tests. The results are high effectiveness, relatively independent of the flow velocity.

■ Exchanger surface area: The amount of heat transmitted is directly dependent on the exchanger surface area. With the number of plates, i.e. their spacing, the effectiveness is easily changed, optimised or selected to meet a particular specification. Therefore different plate spacings are available for most types of Hoval series plate heat exchangers. The optimum exchanger can only be selected with an economic calculation directly concerning a specific project.

1.2 Leakage

Components of air handling units, such as e.g. dampers, ducts or casings, are not normally 100 % leakproof. This is mainly because it is not necessary to ensure the correct function and it would be very expensive. In practical use, however, leakage must not exceed technically justifiable limits. For heat recovery units, there is no such data at the moment. Nevertheless, actual values are known from tests.

A difference has to be made between the following:

- Leakage to outside (external)
- Leakage between supply and extract air (internal)

While sealing to outside normally does not cause any problems (it is above all a question of assembly quality), the internal leakage mainly depends on the system and exchanger construction. The Hoval series plate heat exchanger is particularly tight. Tests have shown the following leakage rates (relating to the nominal air flowrate and a pressure drop of 0.8" w.g. (200 Pa)):

- External leakage: 0.0014 %
  (at a pressure difference of 1.6" w.g. (400 Pa))
- Internal leakage: 0.0158 %
  (at a pressure difference of 1.0" w.g. (250 Pa))

These are excellent results and far better than other manufacturers' data. Nevertheless, it must be noted that exchangers are not 100 % leakproof unless special measures are taken.

Principle and Operation

1.3 Moisture transmission
The two air streams are separated in the Hoval series plate heat exchanger; transmission of moisture is therefore not possible. This is a special advantage when moisture is removed with the warm air, e.g. in swimming pools, drying processes, etc.

1.4 Condensation
Hoval series plate heat exchangers do not transmit moisture but still can use part of the latent heat of moist extract air. At low outside temperatures, when there is a high heat demand, the extract air is cooled down to such a degree that the saturation temperature is reached and condensation is formed. Thus the latent heat of evaporation is released. This reduces further cooling of the extract air, i.e. the temperature difference between the air streams in the plate heat exchanger is greater than when there is no condensation. Also the heat transfer is better; consequently the effectiveness is raised significantly. This can be seen clearly in the hx diagram. The cold air stream is heated more than the warm air is cooled. Nonetheless the enthalpy difference is the same, assuming equal water content.
Condensation in the extract air reduces the free area of the airway and is responsible for an increase in pressure drop. Therefore it is important that the condensation can drain away. This depends mainly on the fitting position of the heat exchangers and on the form of the plates. Hoval series plate heat exchangers offer advantages because of their special profiles.
If condensation occurs the internal and external leakage of the exchanger is of particular importance. Even with a leakage rate of only maximum 0.1 % of the nominal air flowrate – as with the Hoval plate heat exchanger – up to 0.26 gallon (3 litres) condensate an hour can leak out, even more in extreme cases. The absolute value depends on the size of the exchanger, the number of plates, the amount of condensate and the pressure difference.

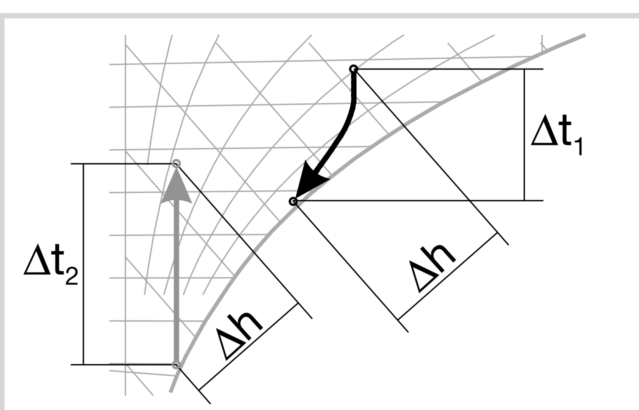


Fig 1-2: Changes of condition in the hx diagram

1.5 Temperature profile
With the cross-flow heat exchanger, the air streams are not heated and cooled evenly. This means that the temperatures vary along the cross section of the air stream. The computer graphic, calculated by the finite element method, shows this.
Because of the temperature variation the verification of the effectiveness under operating conditions is practically impossible. For this reason, the performance of representative Hoval series plate heat exchangers has been empirically tested, measured and agreed by independent test institutes – to safeguard the consultant, installer and operator. The technical data of Hoval series plate heat exchangers are certified by ARI.

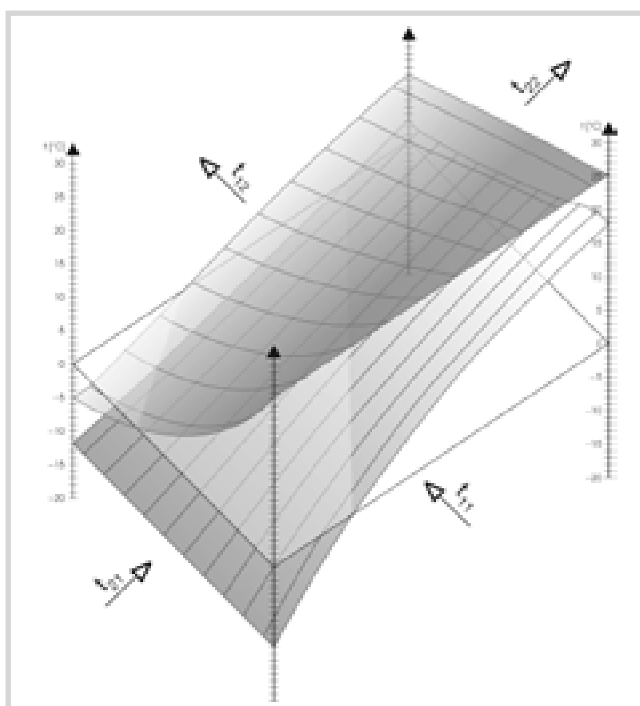


Fig. 1-3: Temperature profile of the air streams (computer graphic)

1.6 Frost limit

If the warm air stream is severely cooled down, it is not only possible for condensation to form, but also to freeze. The cold air temperature at which freezing starts, is called the 'frost limit'. In practice this is rare as several factors must coincide:

- Very low temperature of the cold air stream
- Cold air volume is greater than warm air volume.
- High effectiveness of the exchanger
- Relatively little condensation
- The condensation cannot drain away easily.

If several of these circumstances coincide the plate heat exchanger can ice up, starting at the cold corner. The Hoval series plate heat exchanger is not damaged, but the pressure drop is increased and the air flowrate is reduced. In extreme cases the whole exchanger can slowly ice up. Long experience shows that this is very rarely the case. When designing under the following conditions, the frost limit need not be considered:

- Mass flow ratio cold air to warm air $m_2/m_1 < 1$
- Lowest cold air temperature > 5 F (-15 °C) (mostly the case when no night operation)
- Normal installation of the heat exchanger, i.e. the plates are vertical.
- Exhaust air flowrate can be reduced for short periods.

If these conditions are not met, it is recommended to calculate the frost limit for each project with the computer program and to take necessary precautions (de-icing exhaust fan switch, preheating, bypass).

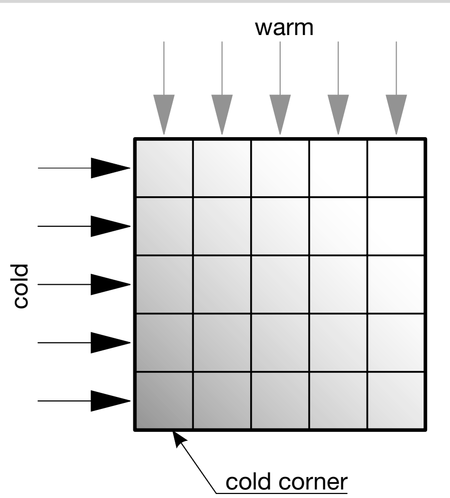


Fig. 1-4: Under extreme conditions the exchanger can ice up, starting at the 'cold corner'.

1.7 Heat recovery effectiveness

In principle, nearly any effectiveness can be achieved if sized and designed to suit. For instance, the effectiveness can be substantially raised by installing two exchangers in series. However, this increase in effectiveness

- either is at the expense of a high pressure drop,
- or at the expense of a large space requirement,
- but in any case at the expense of costs.

The 'correct' effectiveness is a subjective decision and depends on the economic calculation, i.e. on operating data such as energy prices, useful life, running times, temperatures, maintenance costs, interest rates, etc. It is important that the calculated optimum values for heat recovery effectiveness and pressure drop are then put into practice. Even small deviations (a few percent less effectiveness, a few pascals more pressure drop) can cause substantially worse values for the present value and payback period. With regard to profitability and environmental protection the heat recovery effectiveness should be at least 50 %.

1.8 Pressure drop

Heat recovery units cause additional pressure drop on the extract and fresh air sides; incurring higher running costs. Under present conditions the economical values range between 0.6” w.g. (150 Pa) and 1.0” w.g. (250 Pa). However, to cut down costs, heat recovery units whose pressure drop exceeds these values are often installed. The profitability of heat recovery is thereby jeopardised. But there is also an economic limit: The effectiveness for generation of electrical current ranging between only 35 % to 40 %, the expenditure for the additional pressure drop must not exceed this value in relation to the energy savings in total.

1.9 Pressure difference

A distinction is made between
- the internal pressure difference (between fresh air and extract air) and
- the external pressure difference (between inside and outside of the exchanger).

■ External pressure difference: This pressure difference has a major effect on the external leakage of the plate heat exchanger. Yet when the exchanger is properly and carefully installed in a ductwork system, its effect can be neglected. More important is the influence on mechanical resistance. Particularly the side walls are heavily stressed at big pressure differences. Hoval therefore strengthens the side walls of large plate heat exchangers with a special reinforcing section.

■ Internal pressure difference: Likewise, the internal pressure difference has a crucial influence on internal leakage between the two air streams. Although Hoval series plate heat exchangers are very tight in comparison with other constructions, the following should be considered when designing:
- The pressure difference in the heat exchanger should be kept to a minimum.
- The pressure gradient and thus leakage should be from the supply air to the extract air side.

The internal pressure difference also may cause a deformation of the plates. The plate spacing is then narrowed and/or widened, resulting in corresponding variations of pressure drop (up to 20 %).

Extensive tests have shown that the influence of deformation depends on the plate spacing. An internal overpressure exceeding the permissible value of 10” w.g. (2500 Pa) show that the pressure drop strongly increases with small plate spacings whereas it hardly changes with big plate spacings.

The pressure difference depends on the position of fans. Overpressure on one side and underpressure on the other side add up.

The permitted pressure difference between the two air streams is limited to 10” w.g. (2500 Pa).

2 Performance Control

The Hoval series plate heat exchanger operates as a temperature moderator between the two air streams. The direction of the heat transmission is of no consequence, i.e. depending on the temperature difference between extract and fresh air, either heat recovery or cool recovery takes place. Therefore performance control of the Hoval series plate heat exchanger is not necessary when the extract air temperature is identical to the desired room temperature. In this case, the outside temperature is always either heated or cooled through the plate heat exchanger in the direction of the set tempera-ture.
In many cases, however, heat gains are present in the ventilated space (people, machinery, lighting, solar, process plants), which increase the room temperature, so that the extract air temperature is higher than the set temperature. In this case, at full performance of the heat exchanger, check at which outside temperature heat-up begins, and if this cannot be tolerated, the performance of the heat exchanger must be regulated.

Example

In an industrial building the room air is heated from 18 °C to 24 °C through lighting and machinery. The heat recovery figure Φ_2 is 66 %. At which outside temperature t_{21} is the space heated only by heat recovery without additional heating?

$$t_{21} = \frac{t_{22} - (\Phi_2 \cdot t_{11})}{(1 - \Phi_2)}$$

$$t_{21} = \frac{18 - (0.66 \cdot 24)}{(1 - 0.66)} = 6\ °C$$

At an outside temperature of +6 °C the supply air temperature after the heat exchanger is 18 °C = set temperature. At higher outside temperatures the hall is heated above the desired room temperature, this means the performance of heat recovery should be controlled.

With the Hoval series plate heat exchanger the performance control through change of the mass flow ratio is simply and economically accomplished with the bypass. Whether a bypass is fitted on the side or in the middle depends on local conditions and on the width of the exchanger. The arrangement of further ventilation components after the

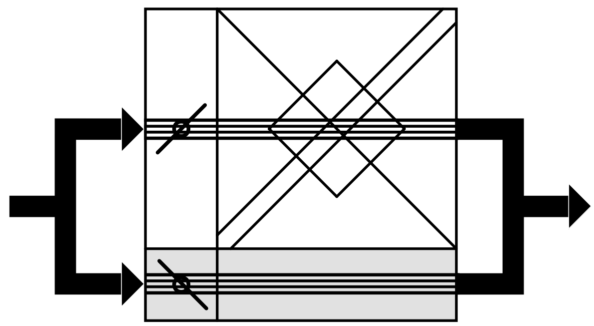


Fig. 2-1: The bypass is most effective for the control of performance.

bypass, e.g. air heater, moisture eliminator, etc., must take into consideration the fact that the velocity profile can be uneven.

There are two options for the fitting of the bypass:

- **Bypass in the fresh air:**
Depending on damper position, between 0 % and 100 % of the fresh air passes through the bypass. The extract air always flows through the heat exchanger and is cooled according to the fresh air flowrate. With this arrangement the cooling of the extract air and thus freezing can be avoided.

- **Bypass in the extract air:**
Between 0 % and 100 % of the extract air passes through the bypass. The fresh air always passes through the plate heat exchanger. This arrangement is recommended when the extract air is very dirty, as during summer operation the extract air does not pass through the plate heat exchanger.

3 Construction

Hoval series plate heat exchangers consist of the exchanger package and the casing. Sizing of the exchanger package (plate size and plate spacing) depends mainly on the air flowrate. To achieve an optimum result with regard to heat recovery effectiveness, pressure drop and costs Innergytech proposes different sizes and spacings:

- design N
  with plate spacings from around 0.118 to 0.248 inches
  (3 mm to 6.3 mm)

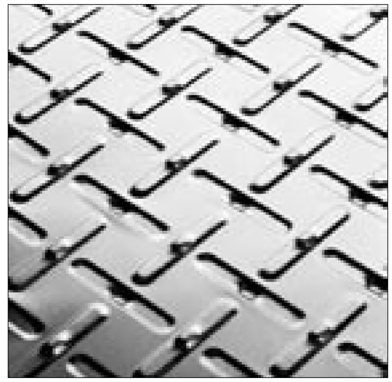


Fig. 3-1:
The special profiles of Hoval series plates are the result of extensive tests and measurements (design N shown here).

3.1 Exchanger package in design N

The exchanger package consist of specially formed aluminium plates. The profile has been optimised by extensive tests for heat recovery effectiveness, pressure drop and stability. The important advantages are:

- Little dependency of the heat recovery effectiveness on the air velocity
- Exact spacing between the plates through positive/negative stamping
- High rigidity of the thin aluminium plates through the special arrangement of the vertical and horizontal ribs
- The profiles are arranged in such a way that the condensation can drain in every direction.
- Uneven flow patterns can even out inside the heat exchanger.

There are three different plate sizes, which are formed with different profile depths, i.e. for different plate spacings. Thus a great variety of different exchanger packages can be made, independent of width.

Fig. 3-2:
Folded connections give the exchanger package severalfold material thickness for the leading and trailing edges (design N shown here).

3.2 Plate connection

In both designs the connection of the plates is made by a fold. This gives a severalfold material thickness for the leading and trailing edges, which gives good rigidity to the exchanger package. Also a streamlined flow profile is given, which reduces not only pressure drop but also the possibility of dirt deposits.

With casting of the corner sealants, the plate fold is additionally sealed with casting resin. Thus the exchanger package is extremely leakproof.

3.3 Casing

The exchanger package is fitted into a casing of aluminium corner sections with side walls of Galvanized sheet steel. The specially developed sections are particularly important:

- The edges of the exchanger package are cast into the sections with a resin. This technique, which is patented by Hoval, ensures optimum integration of the package into the casing.
- Other components can be bolted or riveted directly to the hollow sections without affecting the rigidity of the exchanger or damaging the exchanger package.
- At the corners the sections are flattened by 45°, which facilitates installation of the plate heat exchanger and reduces the diagonal dimension.

The side walls are bolted to the corner sections (each with three screws). This creates flat surfaces for connecting ducts or other components. A punched seal between corner section and side wall ensures highest tightness. Attractively shaped plastic elbow pieces finish off the side walls. In addition, they allow installation of a side sealing all round together with the returned edge. This facilitates installation into a casing.

With very wide exchangers, stability of the casing is additionally improved by the installation of intermediate walls at regular intervals.

The side walls of all compound plate heat exchangers have a special profile for a sealing bead. This together with the sealing bead in the corner section ensures tight connection of the individual exchanger blocks.

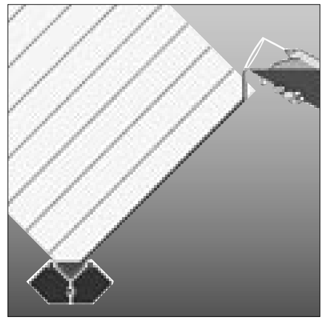


Fig. 3-3: When casting the corner section the plate connection is sealed again.

Fig. 3-4: The specially developed aluminium corner sections offer many advantages.

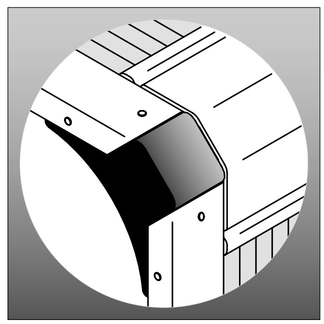


Fig. 3-5: The side walls are finished off with plastic elbow pieces.

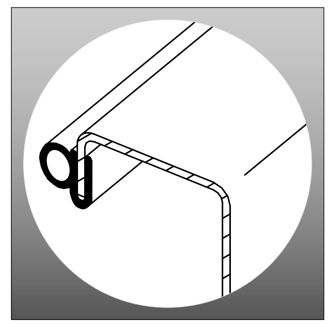


Fig. 3-6: A side sealing can be fastened to the returned edge of the side wall.

Fig. 3-7: The circumferential sealing bead in the frame of each exchanger block ensures tight connection of compound exchangers (here a cut-away model).

4 Model Range

To achieve the optimum solution for all applications, the Hoval series plate heat exchanger is offered in different series and sizes.

4.1 Designs
Depending on usage and air flowrate different design possibilities of Hoval plate heat exchangers are available.

4.2 Series
Three different material types are available:

Series V (standard)	The exchanger package consist of aluminium plates. This provides highest possible resistance against corrosion. The corner sections are made of aluminium extrusions. They are fastened to the rigid side walls of Galvanized sheet steel. The plate package is cast into the corner sections with permanent elastic resin; the exchangers are silicone-free. The maximum permissible temperature is 212 F (100 °C).
Series T (high temperature)	The construction is identical to series V, except: • Instead of the permanent elastic casting resin a high-temperature silicone is used for sealing of the corner sections. • Instead of the plastic elbow piece a metal cover is used. Thus the exchangers are resistant to temperatures up to 392 F (200 °C).
Series G (corrosion-protected)	The basic materials correspond to those of series V, however, the complete casing and the plates are coated. The exchangers are silicone-free. The maximum permissible temperature is 212 F (100 °C). This series is used when large amounts of condensate occur, in wet rooms, swimming pools, etc., and for mild corrosion (industry, process technology, etc.).

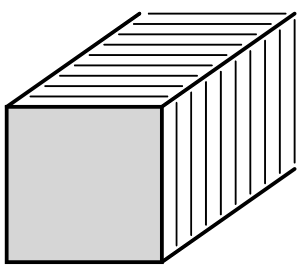
4.3 Exchanger sizes

The exchanger package is responsible for the air performance (heat recovery effectiveness, pressure drop, air flowrate). Depending on the design, different sizes are available.

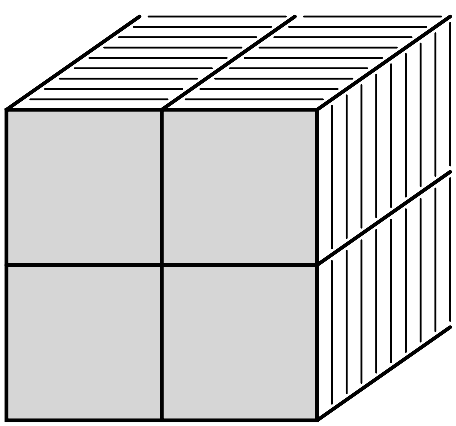
■ Exchangers in design N: Innergytech manufactures six different sizes. The size designation indicates the exchanger lengths in centimetres.

060	070	085	120	140	170

Sizes 060 to 085 consist of one exchanger package, sizes 120 to 170 are compound exchangers, made up of four exchanger packages.



Design N	060	070	085



Design N	120	140	170

Fig. 4-2: Individual plate heat exchangers are constructed from different exchanger packages.

4.4 Plate spacing

The plate spacing effects the surface area and thus the heat recovery effectiveness, the pressure drop and the price. Hoval offers several spacings for most sizes so that an optimum solution can be achieved for each project.

R =	Small spacing	= Very high heat recovery effectiveness
X =	Middle spacing	= High heat recovery effectiveness
L =	Large spacing	= Middle heat recovery effectiveness
W =	Very large spacing	= Low heat recovery effectiveness

The approximate plate spacing is calculated from the width of the exchanger package b divided by the number of plates. Depending on the width, minor deviations from the nominal value are possible in practice.

Plate spacing	**Design N**					
	060	**070**	**085**	**120**	**140**	**170**
R	3.0	3.3	3.9	5.0	5.3	6.3
X	4.0	4.3	5.1	6.3	6.3	
L	5.0	5.3	6.3			
W	6.3	6.3				

Table 4-1: Nominal values of clear plate spacings (in mm) design N

4.5 Exchanger width

The width of the Hoval series plate heat exchanger can be as desired. It can be selected according to local conditions and design criteria (e.g. pressure drop). For stability reasons, but also to simplify transport and installation, the maximum exchanger width is limited to 118.1 inches (3000 mm).

Application limits

5 Unit Type Reference, Application Limits, Specification of Material

Hoval series plate heat exchangers are clearly defined with the unit type reference. This shows all possibilities for design and options.
Table 6-1 shows which limits are to be respected when planning, designing and operating.

6 Exchanger Dimensions

The following drawings show various designs and exchanger sizes. The dimensions given are those relevant for connection of the plate heat exchanger. For clarity, details of type sizes made up of four exchanger packages have been omitted.

	Temperature	Width	Pressure differential	Pressure diff. to outside	Pressure drop
Design V and G	-40...212 F (-40 ... 100 °C)	2.75...118.1 in (70 ... 3000 mm)	max. 10" w.g. max. (2500 Pa)	max. 10" w.g. max. (2500 Pa)	Pressure drop should not exceed 1.2" w.g. (300 Pa) for economical reasons. Recommended: 0.6...0.8"w.g. (150 ... 200 Pa)
Design T	-40...392 F (-40 ... 200 °C)	2.75...118.1 in (70 ... 3000 mm)	max. 4" w.g. max. (1000 Pa)	max. 4" w.g. max. (1000 Pa)	

Table 5-1: Application limits for Hoval plate heat exchangers

	Series V	Series G	Series T
Plate exchanger			
Plates	Aluminium	Aluminium epoxy-coated	Aluminium
Casing	Galvanized sheet steel Aluminium sections	Galvanized sheet steel wet-painted red (RAL 3000) Aluminium sections wet-painted orange (RAL 2008)	Galvanized sheet steel Aluminium sections
Sealing	Casting resin	Casting resin	HT silicone

Table 5-2: Specification of material for Hoval series plate heat exchangers

Unit Type Reference

Example of unit type reference

NV - 060 / X - 085 - L

Design

N = Design N

Series

V = Standard
G = Corrosion-protected
T = High-temperature

Size

Code for the size of the exchanger plates

Plate spacing

R = small
X = middle
L = large
W = very large

Exchanger width in cm (outside dimension)

Options

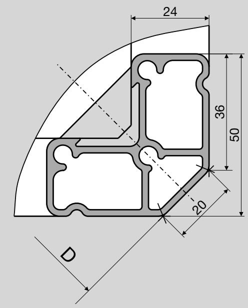
L = Horizontal installation

Table 5-3: Unit type reference for Hoval series plate heat exchangers

Exchanger Dimensions

		Design N (in mm)					
Exchanger size		**060**	**070**	**085**	**120**	**140**	**170**
Height, length	**H = L**	600	700	850	1200	1400	1700
Diagonal	**D**	829	970	1182	1677	1960	2384

Detail A



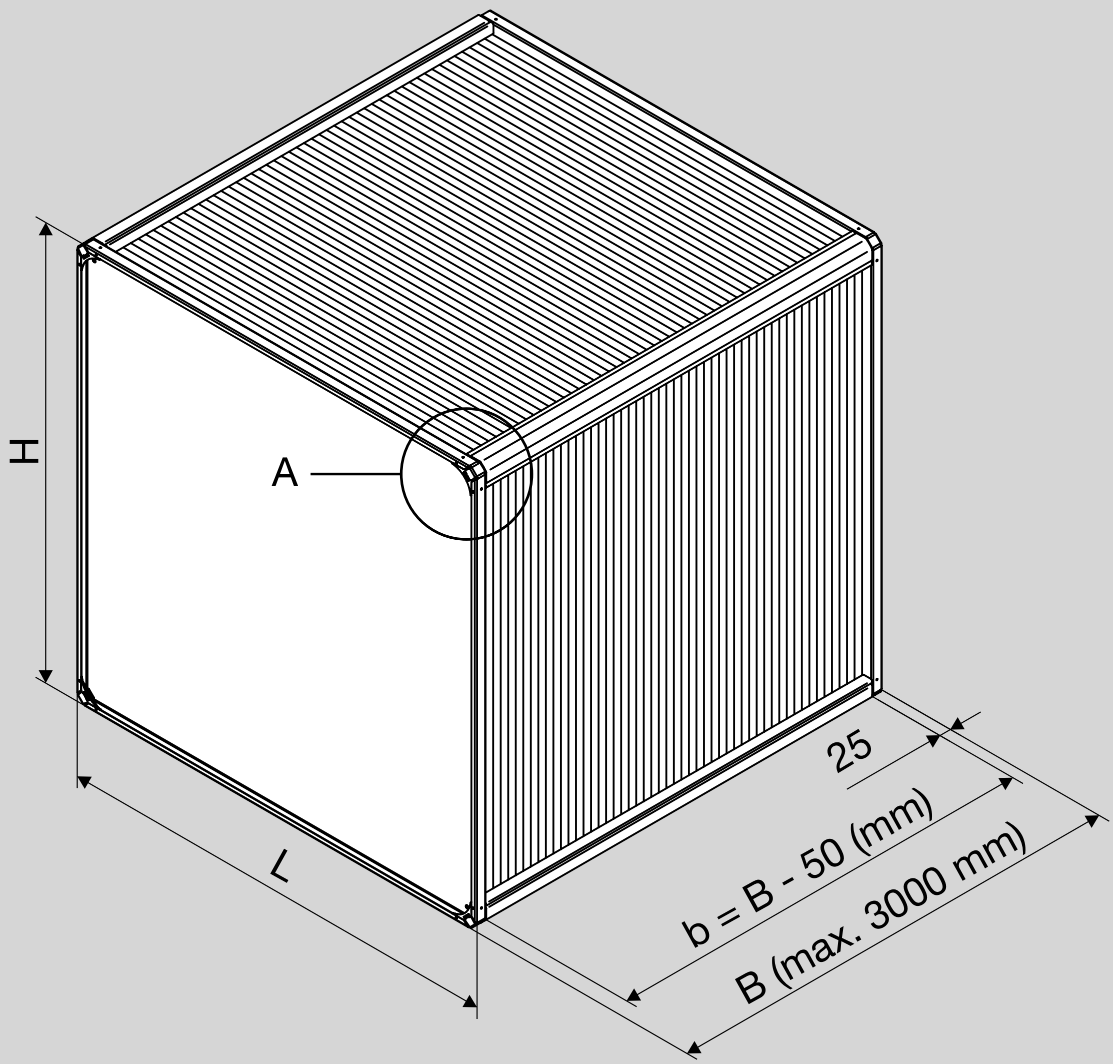


Table 6-1: Dimensions of exchangers without bypass (in mm)

7 Design Guidelines

7.1 Selection program Winnergy

The design of Hoval series plate heat exchangers is easy and quick with the selection program Winnergy. It runs under Microsoft® Windows and offers the following:

- Reliable design data thanks to ARI-certified data
- Exact calculation of a specific Hoval series plate heat exchanger
- Calculation of all appropriate plate heat exchangers for a specific project
- Price calculation

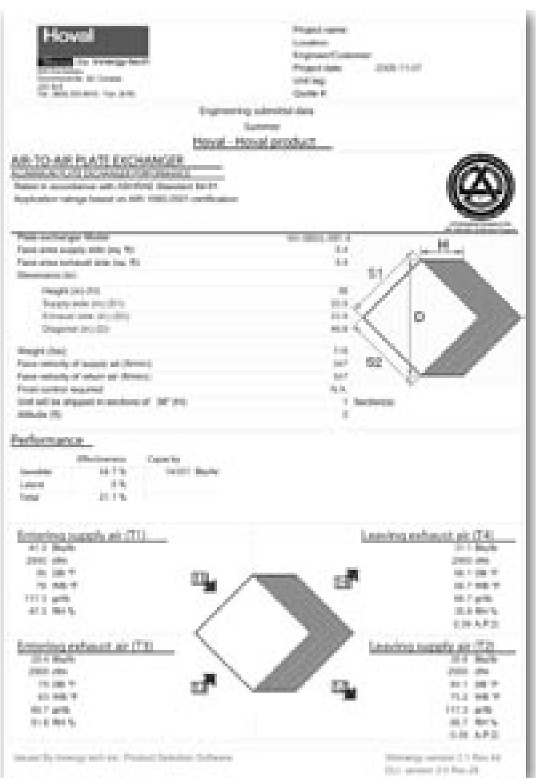


Figure 7-1: The design of Hoval series plate heat exchangers is easy and quick with the selection program Winnergy.

7.2 Design data

When designing, correct data is essential to achieve the desired values. This is often particularly difficult in air handling installations because the specific density and specific heat are dependent on temperature. Also the water vapour contained in the air is very important for the design. For an exact calculation of a plate heat exchanger the air conditions at entry to the exchanger are required.

Extract air	Air flowrate at exchanger entry
	Rel. humidity at exchanger entry
	Temperature at exchanger entry
Fresh air	Air flowrate at exchanger entry
	Temperature at exchanger entry
	Rel. humidity at exchanger entry

Table 7-1: Design data for plate heat exchangers.

The following errors should be avoided when collecting the data:

- For winter operation the moisture in the air is often estimated too high. (Where does the moisture come from?)
- Are the temperatures (fresh air, extract air) really as stated in practice (or are they wishful thinking)?

7.3 Rules and guidelines

Ascertain before designing which rules and guidelines apply. For instance, for some applications (e.g. hospitals) some heat recovery systems are not suitable or can only be allowed after appropriate proving.

7.4 Positioning of unit and system layout

- Where should the heat recovery unit be positioned?
- Which is the optimum air path?
- Which dimensions are allowed?

These questions are important when selecting a plate heat exchanger and should be thoroughly examined in advance. Little general recommendation can be given for positioning and air path. Only take care that condensate, if present, can drain freely and does not remain inside the exchanger, thus causing a higher pressure drop. This is always guaranteed with a downward extract air flow. Yet, in practice all possible airflows and positions are used without any problems. Section 5.6 gives special tips for horizontal installation.

7.5 Cost-effective design

If the calculation is not carried out with the Innergytech selection program Winnergy, select the most economical type, regarding effectiveness and/or plate spacing. The following rules apply:

- Long periods of operation (e.g. 3 operating shifts)
  → high effectiveness
- Long life span of unit
  → high effectiveness
- High extract air humidity and thus improved effectiveness through condensation
  → medium, large or very large plate spacing
- High dirt hazard
  → large or very large plate spacing

When using plate heat exchangers in process technology, ascertain whether the heat recovery figure is limited due to supply air temperature.
The optimum plate heat exchanger selection can only be based on an economic calculation.

7.6 Twin exchangers

If a particularly high effectiveness is required it is possible to connect two or even more plate heat exchangers in series.

Various arrangements are possible; the important thing is that the two air streams pass each other in cross flow.

7.7 Performance control

Check which internal heat sources are available in the hall. If the extract air temperature is expected to be clearly higher than the desired temperature, a performance control of the plate heat exchanger should be considered (see section 2).

7.8 Recirculation bypass

If the air handling installation allows for recirculation operation as well (e.g. during the night) this can also be achieved with a recirculation bypass in the plate heat exchanger.
If recirculation is also possible during fresh air operation, reasonable control priorities (recirculation/heat recovery) must be defined.

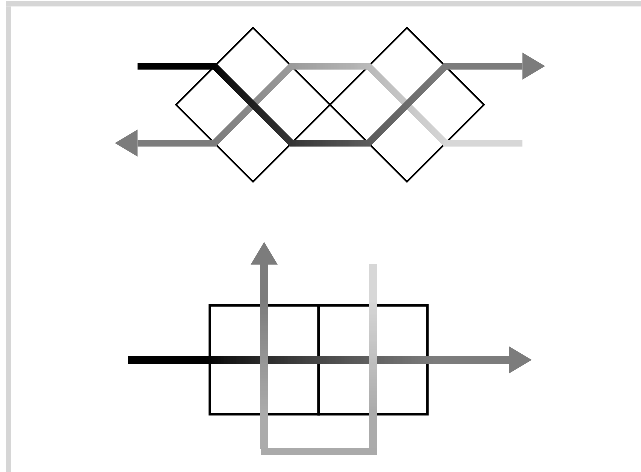


Fig. 7-2: Twin exchangers offer interesting connection possibilities and highest heat recovery values.

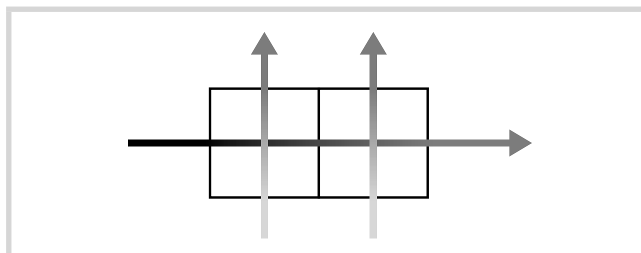


Fig. 7-3: For unequal mass flow rates check parallel flow or counter flow arrangements.

7.9 Sound attenuation

Plate heat exchangers have a sound-dampening effect. The performance depends on the plate size and spacing. More details based on various tests and theoretical considerations are available upon request.

7.10 Corrosion

Series V of Hoval plate heat exchangers has proved satisfactory for installation into air handling equipment. If corrosion is expected – e.g. in swimming pools, kitchens, and certain industrial applications – series G (corrosion-protected) is used. The Innergytech technical department will advise which series is suitable for specific applications.

7.11 Application limits

Prior to selecting a plate heat exchanger, check if any application limits have been exceeded (temperature, pressure difference).

7.12 Dirt build-up

In 'normal' air handling equipment the air streams are cleaned mostly by coarse dust filters. Therefore there is no dirt hazard for the plate heat exchanger, but if this is expected, in specific applications, consider the following:

- Position the exchanger in such a way that it can be cleaned easily or
- install in such a way that it can easily be removed for cleaning.
- Fit inspection ports before and after the plate heat exchanger.
- If possible, filter the air streams so that dirt built-up is minimised or cleaning intervals are longer.

It was found in practice that dirt built-up is far less than expected. The Innergytech technical department will advise.

7.13 Condensation in the warm air stream

Plate heat exchangers are not 100 % leakproof unless special measures are taken (see section 1.2 and 1.4). Therefore, if condensation is expected:

- Install condensate drip trays on the supply and extract air side.
- Position the fans in such a way that the pressure gradient and thus leakage is from the supply to the extract air.

When large amounts of condensate are present in the extract air and the air velocity is higher than 8.2 ft/s (2.5 m/s), condensate drops can be carried along with the airflow and enter ducts or other ventilation components downstream of the heat exchanger. To avoid this and thus uncontrolled condensate escape, we recommend that a drop eliminator is installed after the plate heat exchanger.
In addition, check the following and arrange for appropriate measures:

- How is the condensate drained away?
- Is icing-up hazard expected (see section 1.6)?

7.14 Solvent resistance

Plate heat exchangers may sometimes be used in applications where solvents (e.g. acetone, methanol, toluol, xylol, propanol and MEK) are contained in the extract air stream. These attack the casting resin used for sealing the corner sections. On request, we therefore supply a special design as follows:

- Solvent-resistant casting resin
- Solvent-resistant adhesive tape
- Metal cover instead of plastic elbow piece

For such applications please also consider:

- Control dampers must be installed in the (clean) fresh air stream.
- A pressure gradient from the supply air to the extract air side should be provided, avoiding the transmission of solvents to the supply air. (In addition, a leakage test is recommended.)
- Check if the other materials (aluminium, Galvanized, etc.) are resistant to the solvent.

7.15 Operation and function reliability

Hoval series plate heat exchangers do not require power drive, have no moving parts and thus are 100 % reliable in operation.
Therefore it is possible, at the planning stage, to take recovered heat into consideration. The heat generation and distribution required (boilers, heaters, flues) can therefore be dimensioned and selected on a smaller scale. Thus cost savings are already in evidence at the installation stage.

8 Specification Text

Hoval series cross-flow plate heat exchanger for heat recovery, consisting of exchanger package and casing:
The exchanger package consists of aluminium plates with pressed-in spacers; condensate drainage is possible in every direction.
The plates are connected by a fold. This gives a severalfold material thickness at air entry and exit. In addition, the fold is sealed with casting resin.
The corners of the exchanger package are cast and sealed into especially rigid aluminium extrusions in the casing with permanent elastic resin using a patented method. The side walls of Galvanized sheet steel are bolted tightly to these extrusions.
All performance data is ARI-certified.

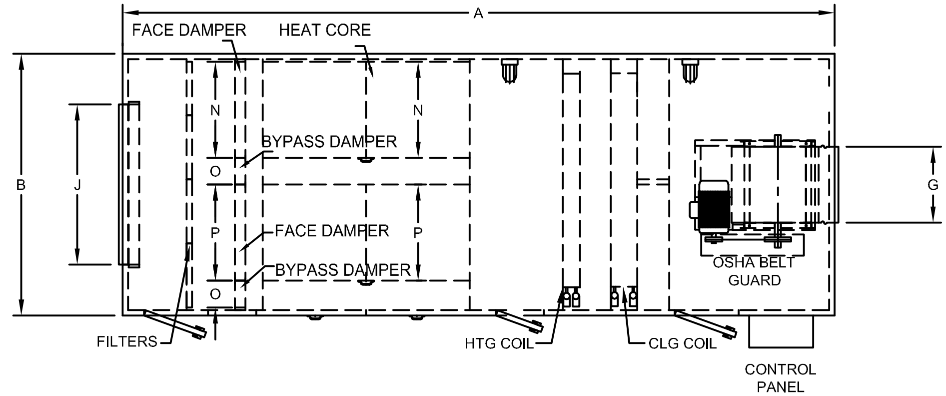
Series V (standard):
Aluminium plates, extruded aluminium sections and Galvanized sheet steel; silicone-free; resistant to temperatures up to 212 F (100 °C).

Series G (corrosion-protected):
All components (Aluminium plates, extruded aluminium sections and Galvanized sheet steel) coated; silicone-free; resistant to temperatures up to 212 F (100 °C).

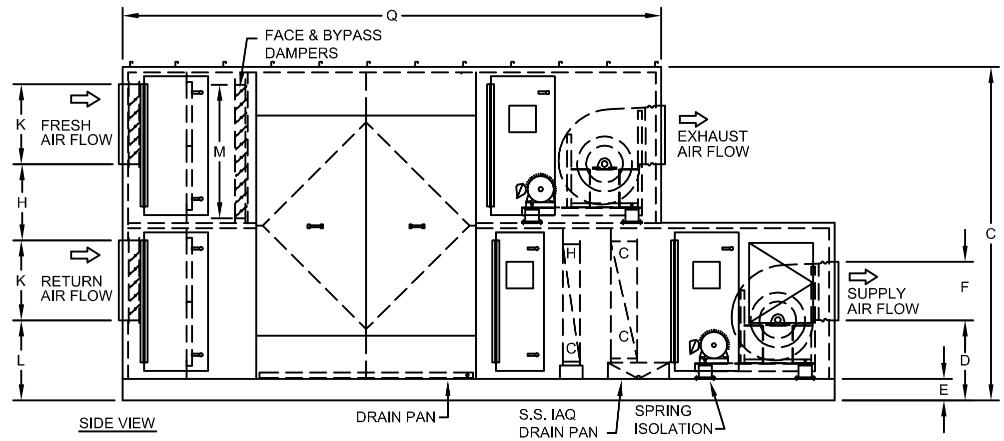
Series T (high-temperature):
Aluminium plates, extruded aluminium sections and Galvanized sheet steel; special sealing agent, resistant to temperatures up to 392 F (200 °C).

Options
- Horizontal installation position must be considered in fabrication.

Technical data
Type
Weight
Height
Width
Length
Warm air
Air flowrate at exchanger entry
Temperature at exchanger entry
Rel. humidity at exchanger entry
Temperature at exchanger exit
Pressure drop (with condensation)
Cold air
Air flowrate at exchanger entry
Temperature at exchanger entry
Rel. humidity at exchanger entry
Temperature at exchanger exit
Pressure drop
Mass flow ratio



TOP VIEW



SIDE VIEW

NOTES:

1. 1 1/2 INLET AND DISCHARGE DUCT FLANGES
2. SERVICE ACCESS PANELS MUST NOT BE OBSTRUCTED RECOMMENDED CLEARANCE 24 INCHES.
3. DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES. FOR REFERENCE USE ONLY, SUBJECT TO CHANGE WITHOUT NOTICE.

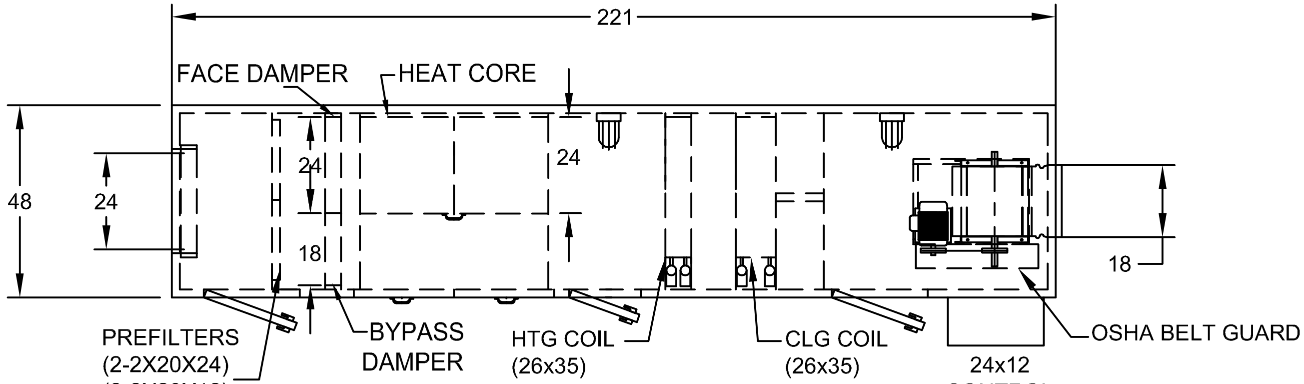
MODEL	CFM	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	HTG COIL QTY/SIZE	CLG COIL QTY/SIZE	S/A & E/A MOTOR (HP)	S/A & E/A FAN (inch)	F/A FILTER QTY/SIZEX2"	R/A FILTER QTY/SIZEX2"	FINAL FILTER QTY/SIZEX12"	CONTROL PANEL SIZE
AH-20-HC	2000	221	48	85	19.5	4	14	18	20.5	24	15	15	35	24	18	0	154	1-26x35	1-26x35	2	12	2-20x24,2-20x12	2-20x24,2-20x12	2-16x25	24x12
AH-60-HC	6000	243	72	106	24	6	16	22	25	40	25	24	40	48	18	0	175	1-35x55	1-32x55	5	15	6-20x20	6-20x20	2-24x24,2-24x12	24x24
AH-80-HC	8000	266	78	115	29	8	19	26	23.5	36	30	25	46	60	10	0	197	1-42x70	1-42x70	10	18	6-24x24	6-24x24	4-24x24	24x24
AH-120-HC	12000	267	98	125	30	8	22	28.5	28.5	60	30	30	50	36	10	36	202	1-44x80	1-44x80	15	20	6-24x24,2-20x24	6-24x24,2-20x24	6-24x24	24x30
AH-150-HC	15000	288	98	130	32	8	24	32	31	60	30	30	55	24	16	36	225	1-50x89	2-25.5x89	20	22	6-24x24,2-24x12	6-24x24,2-24x12	6-24x24,3-24x12	24x30
AH-180-HC	18000	236	108	150	36	8	29	38.5	30	60	40	30	65	36	15	36	236	1-60x90	2-29x90	20	27	12-24x20	12-24x20	9-24x24	24x30
AH-210-HC	21000	309	110	160	39	8	32	43	36	70	40	35	65	36	10	48	245	1-62x98	2-31x98	30	30	8-24x24,4-24x12	8-24x24,4-24x12	9-24x24,3-24x12	24x30

Rev	By	Revision Description	Date

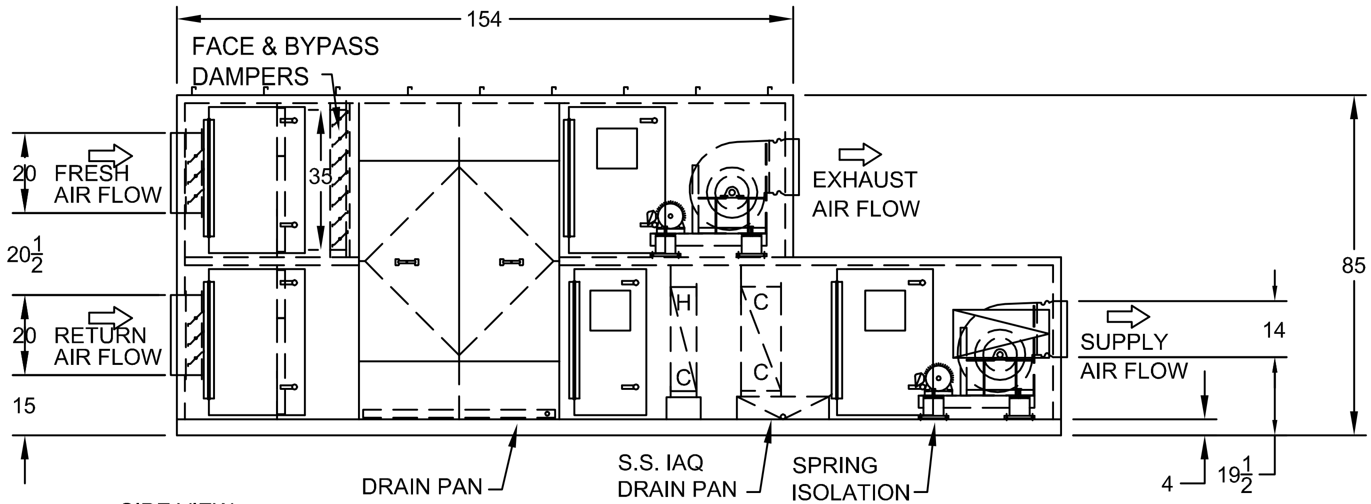
WESTERN SALES

TITLE
CONVERTIBLE WET AIR HANDLING UNIT
W/ HEAT CORE, HEATING/COOLING WATER COILS
BI DWDI FAN c/w MOTOR (SUPPLY & EXHAUST)
MODEL: AH-HC

DRAWN BY	ISSUED BY	SCALE 1/6"=1'	DRW. NO.	
CHK. BY	DATE		JOB NO.	PAGE G-20



TOP VIEW



SIDE VIEW

NOTES:

1. 1 1/2 INLET AND DISCHARGE DUCT FLANGES
2. SERVICE ACCESS PANELS MUST NOT BE OBSTRUCTED RECOMMENDED CLEARANCE 24 INCHES.
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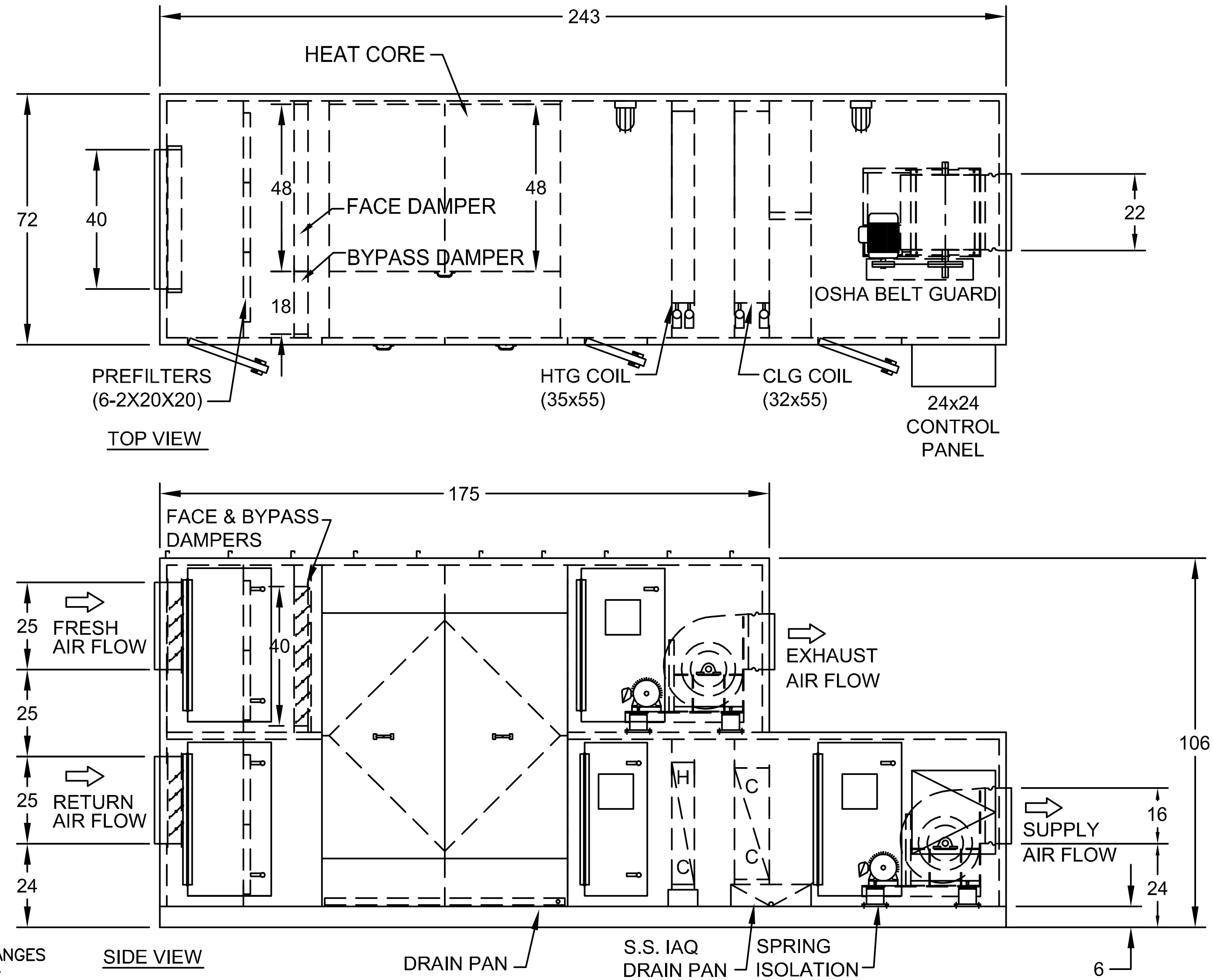
Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE
2,000CFM CONVERTIBLE WET AIR HANDLING UNIT
W/ HEAT CORE, HEATING/COOLING WATER COILS
12" BI DWDI FAN c/w 2HP MOTOR (SUPPLY & EXHAUST)
MODEL: AH-20-HC

DRAWN BY	ISSUED BY	SCALE	DRW. NO.	
		1/4"=1'		
CHK. BY	DATE		JOB NO.	PAGE G-21



NOTES:

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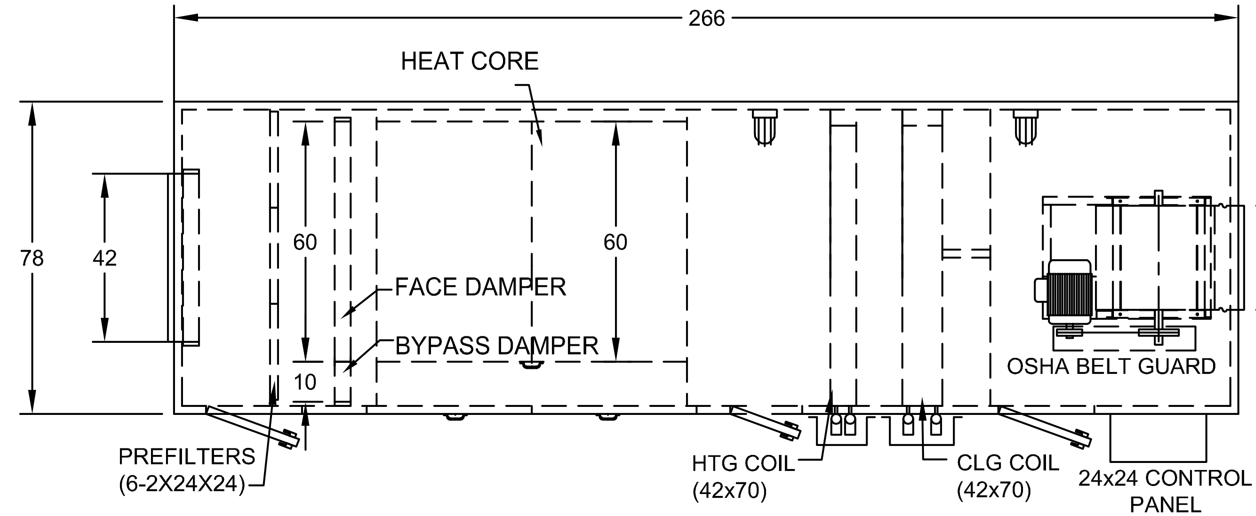
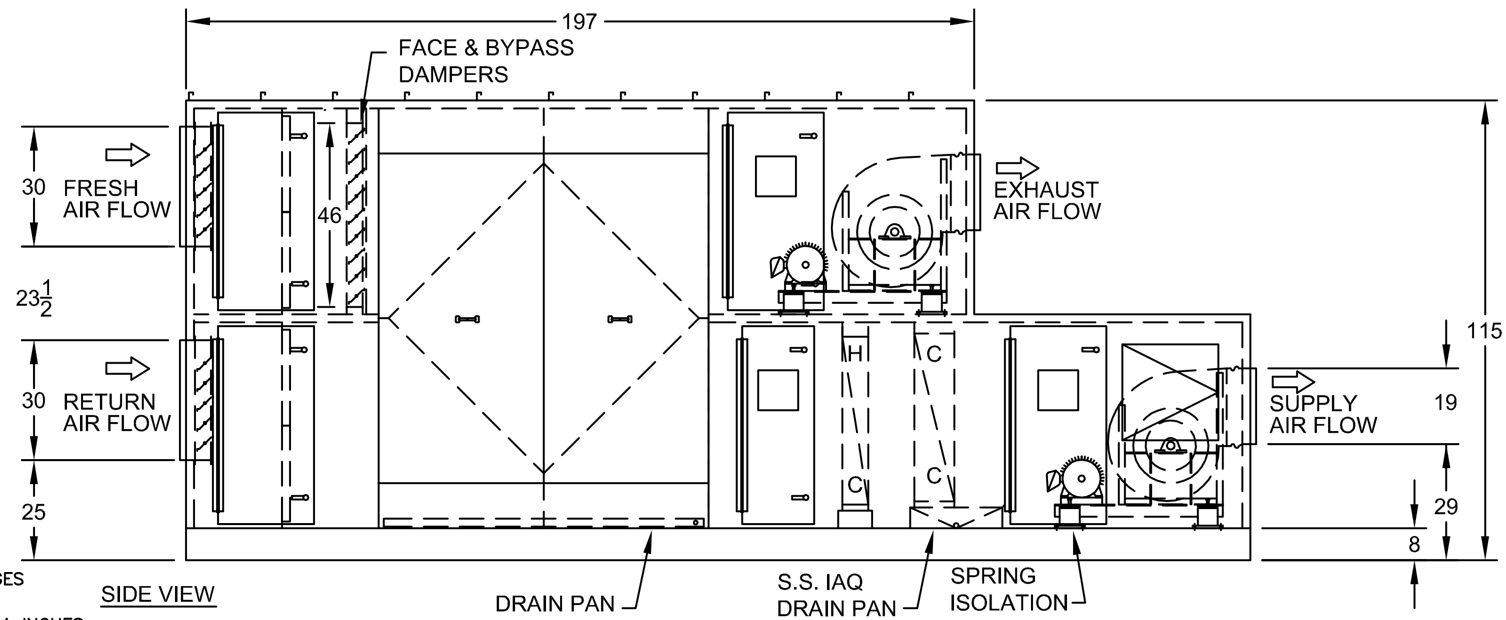
Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE 6,000CFM CONVERTIBLE WET AIR HANDLING UNIT w/ HEAT CORE, HEATING/COOLING WATER COILS 15" BI DWDI FAN c/w 5HP MOTOR (SUPPLY & EXHAUST) MODEL: AH-60-HC			
DRAWN BY	ISSUED BY	SCALE 1/4"=1'	DRW. NO.
CHK. BY	DATE	JOB NO.	PAGE G-22



TOP VIEW



SIDE VIEW

NOTES:

1. 1 1/2 INLET AND DISCHARGE DUCT FLANGES
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Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE
8,000CFM CONVERTIBLE WET AIR HANDLING UNIT
w/ HEAT CORE, HEATING/COOLING WATER COILS
18" BI DWDI FAN c/w 10HP MOTOR (SUPPLY & EXHAUST)
MODEL: AH-80-HC

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		1/4"=1'		
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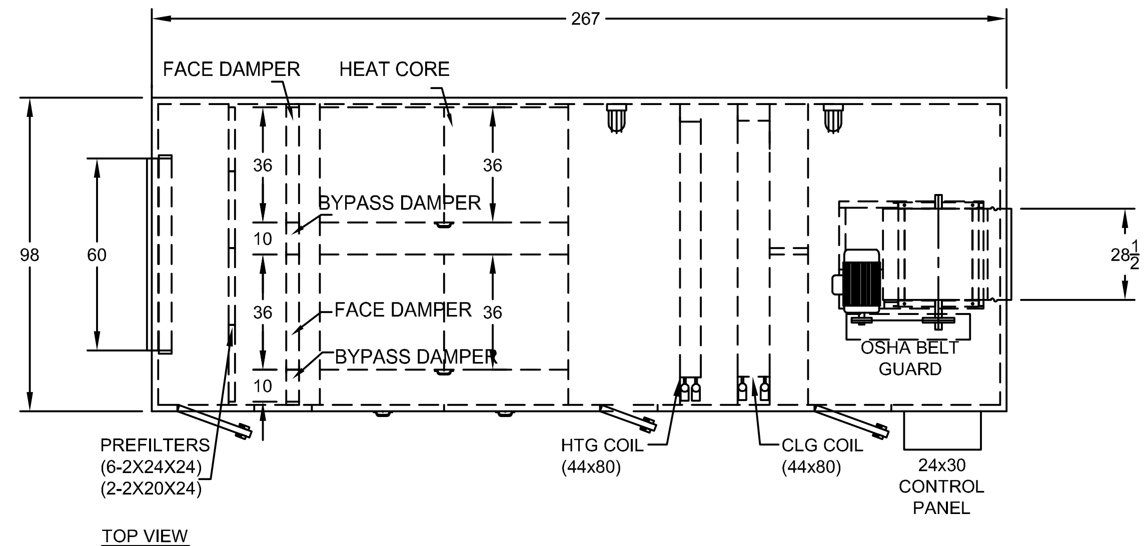
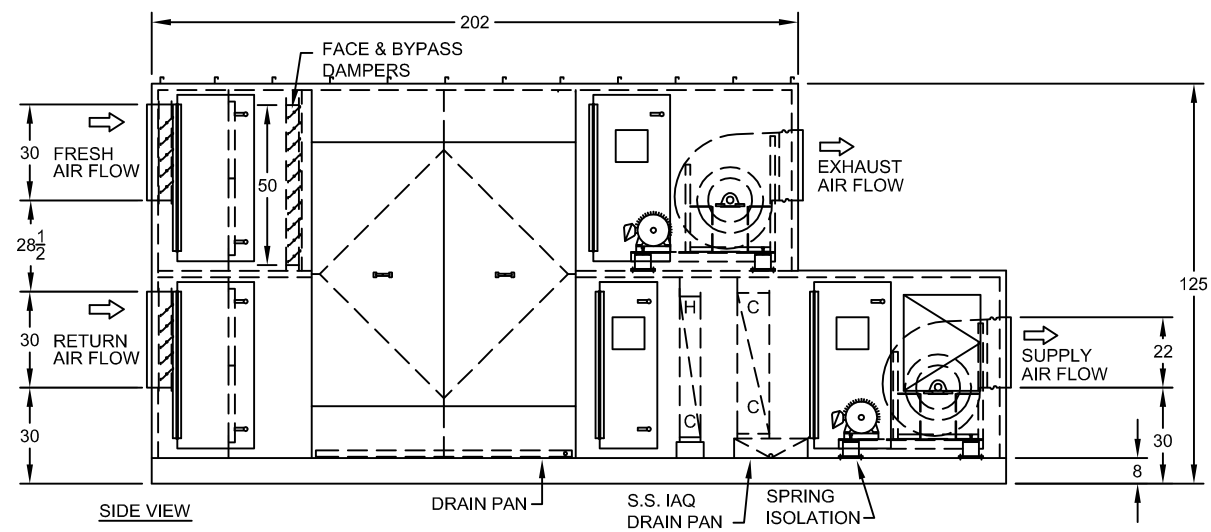
				G-23





NOTES:

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Rev	By	Revision Description	Date

ICG WESTERN SALES

TITLE
12,000CFM CONVERTIBLE WET AIR HANDLING UNIT
w/ HEAT CORE, HEATING/COOLING WATER COILS
20" BI DWDI FAN c/w 15HP MOTOR (SUPPLY & EXHAUST)
MODEL: AH-120-HC

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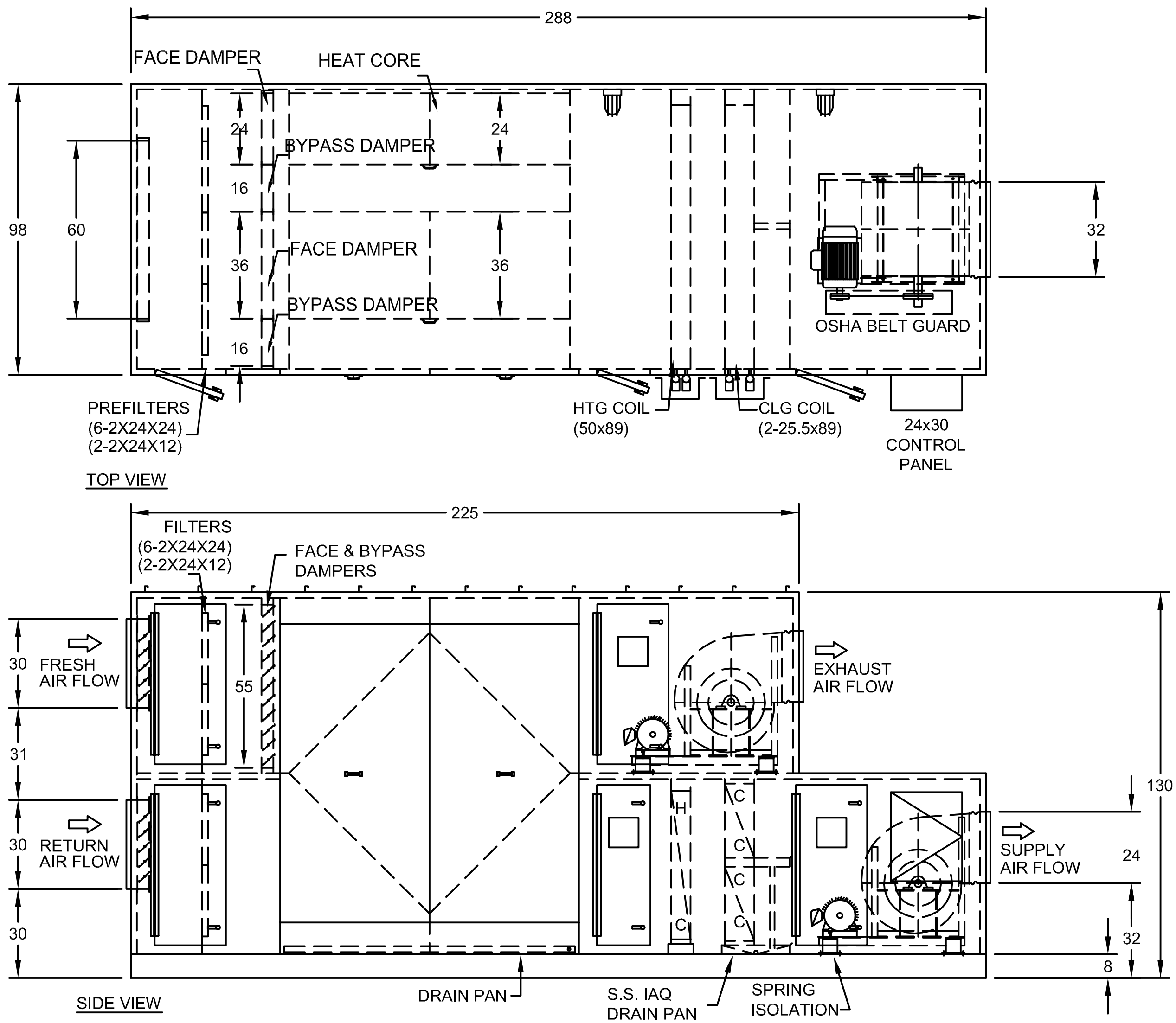
CHK. BY	DATE		JOB NO.	PAGE G-24



NOTES:

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   OBSTRUCTED RECOMMENDED CLEARANCE 24 INCHES.
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   FOR REFERENCE USE ONLY, SUBJECT TO CHANGE WITHOUT NOTICE.

Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE
15,000CFM CONVERTIBLE WET AIR HANDLING UNIT
w/ HEAT CORE, HEATING/COOLING WATER COILS
22" BI DWDI FAN c/w 20HP MOTOR (SUPPLY & EXHAUST)
MODEL: AH-150-HC

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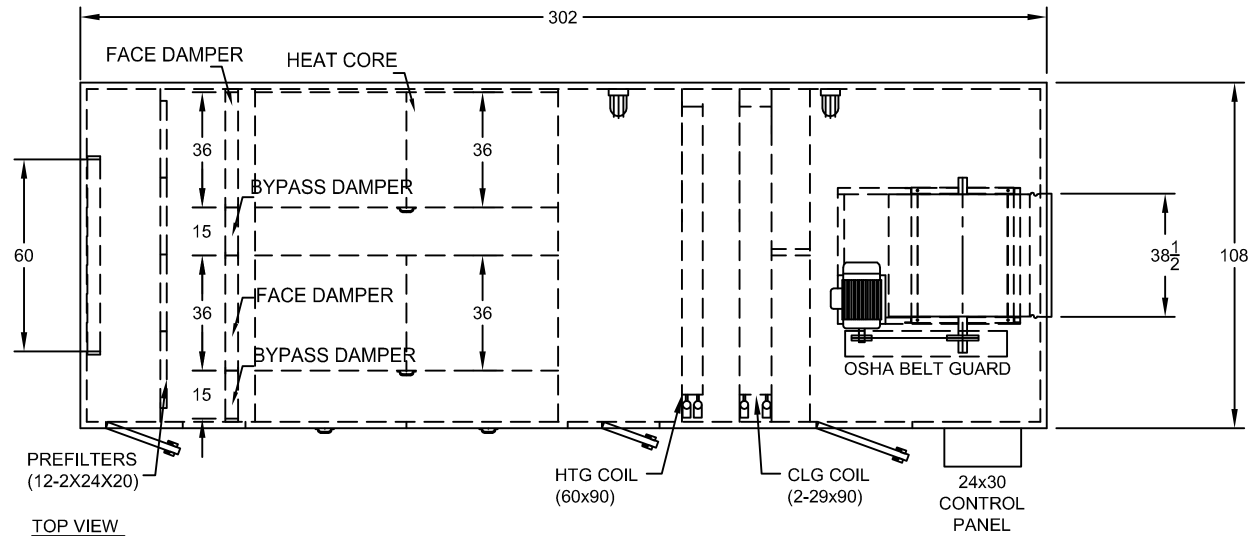
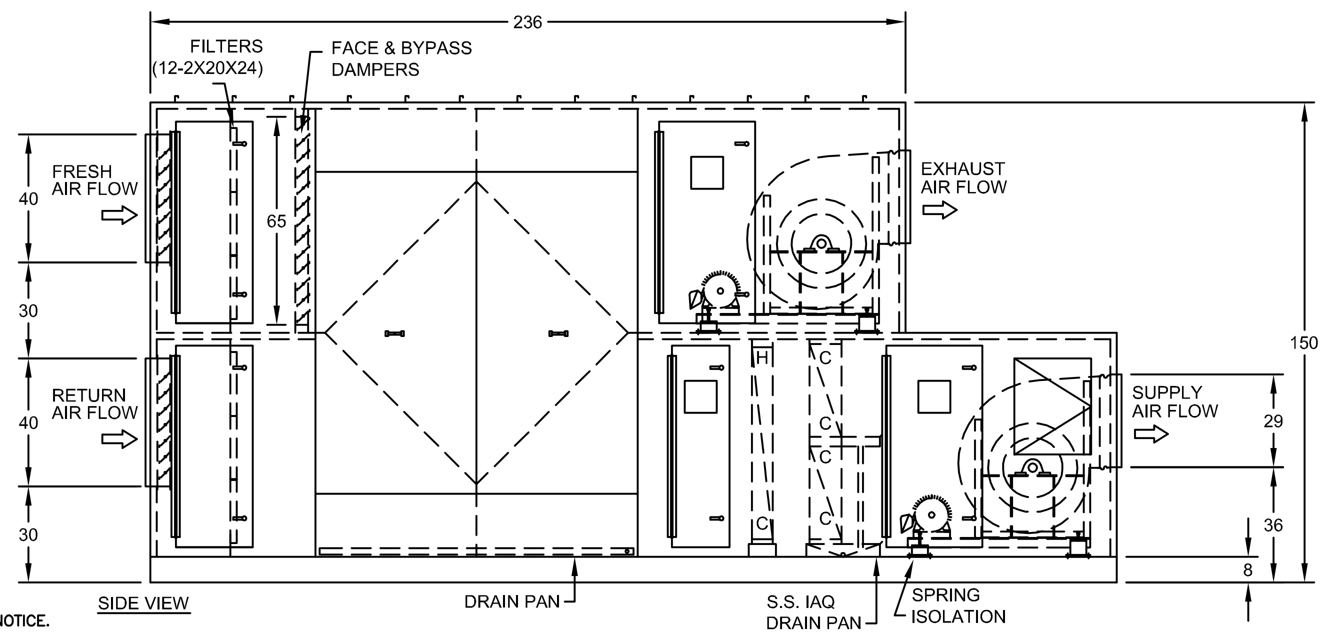
CHK. BY	DATE		JOB NO.	PAGE G-25



TOP VIEW



SIDE VIEW

NOTES:

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Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE 18,000CFM CONVERTIBLE WET AIR HANDLING UNIT w/ HEAT CORE, HEATING/COOLING WATER COILS 27" BI DWDI FAN c/w 20HP MOTOR (SUPPLY & EXHAUST) MODEL: AH-180-HC				
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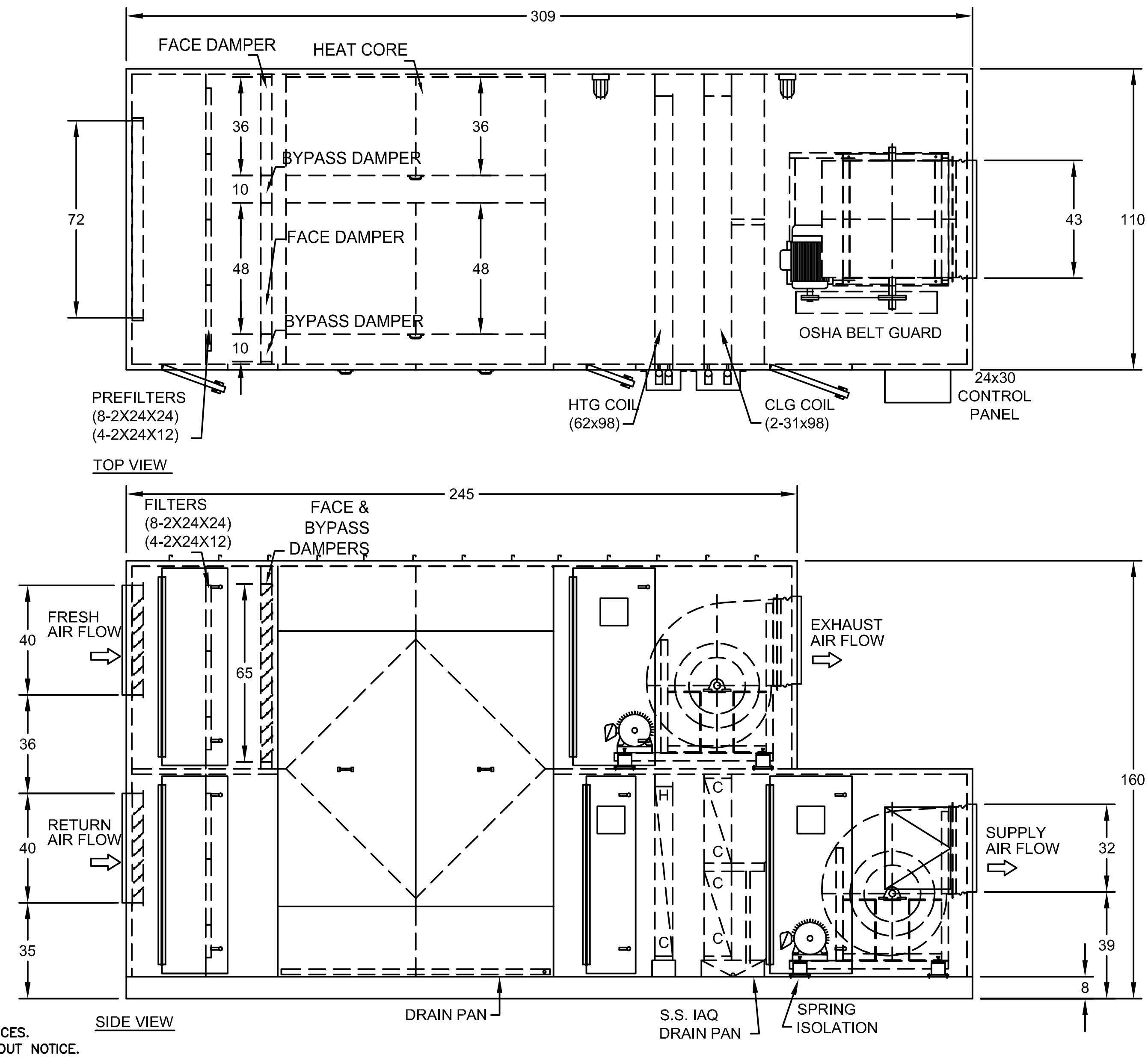
CHK. BY	DATE		JOB NO.	PAGE G-26



NOTES:
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Rev	By	Revision Description	Date

ICE WESTERN SALES

TITLE 21,000CFM CONVERTIBLE WET AIR HANDLING UNIT w/ HEAT CORE, HEATING/COOLING WATER COILS 30" BI DWDI FAN c/w 30HP MOTOR (SUPPLY & EXHAUST) MODEL: AH-210-HC				
DRAWN BY	ISSUED BY	SCALE 1/5"=1'	DRW. NO.	
CHK. BY	DATE		JOB NO.	PAGE G-27

AH SERIES w/ HEAT CORE, HEATING WATER COIL, COOLING WATER COIL, SUPPLY & EXHAUST AIR BLOWER TYPICAL SPECIFICATIONS

CASING

The unit exterior casing shall be heavy gauge G90 rated bonderized steel. Unit roof shall feature standing seam construction. The entire unit casing shall be insulated with 1-in. thick 1.5-lb. (2-in. thick 1.5-lb.) fiberglass insulation with hard neoprene backing in a sandwich wall fashion (22-gauge solid liner). The unit exterior shall be finished with industrial enamel (catalyzed epoxy) paint. An integral welded iron channel frame shall support the unit casing. The structural iron frame shall be sandblasted, primed and finished with industrial enamel (catalyzed epoxy) paint.

BLOWER/MOTOR SECTION

The fan section and motor assembly shall be constructed in accordance with the requirements of the Air Moving and Conditioning Association (AMCA). The assembly shall be designed to house the fan(s), bearings, motor, and v-belts, which shall be selected for at least 50% above the rated motor capacity. The fan(s) and motor shall be mounted on a welded unitary base made of angle iron frame. The frame shall be sandblasted, primed and finished with industrial enamel (catalyzed epoxy) paint. The unitary base shall be provided with seismic spring vibration isolation. The blower section shall have a hinged access door with Ventlock handles to allow easy maintenance of filters and belts. The NEMA T-Frame motor shall be mounted on an adjustable base located within the fan section. The blower wheel shall be statically and dynamically balanced, and mounted on a turned, ground and polished shaft with rigid bearing supports. The shaft shall be designed with a maximum operating speed not exceeding 75% of the first critical speed. The bearings shall be split taper lock ball bearing type L20 minimum life of 100,000 hours (L10 200 kHr).

Fan performance shall be based on tests conducted in accordance with AMCA Standard Test Code for Air moving Devices. (All fans shall have sharply rising pressure characteristic extending throughout the operating range and continuing to rise well beyond the efficiency peak to assure quiet and stable operation under all conditions. Horsepower characteristics shall be truly non-overloading and shall reach a peak in the normal selection area.) Fan manufacturer shall provide sound power ratings in the eight octave bands, which shall be based on AMCA Standard 300-67, test, setup number one. Sound power ratings shall be referenced 10-12 watts. A factory dynamic balance shall be made on all fans after their assembly. An IRD or PMC analyzer shall be used to measure velocity, and the final reading shall not exceed 0.1 inches per second. The exact level of vibration shall be recorded on the fan as proof of the final dynamic balance at the factory.

COOLING CONTROLS

Cooling control shall be achieved via a Honeywell T775 multi-stage sequencer. The sequencer shall be controlled with an analog signal provided by the discharge air thermostat. As the discharge air thermostat requires cooling the signal shall increase, thereby turning on the stages at specific set points. The set points shall be set with appropriate offset and differential to ensure accurate discharge temperature is maintained. The stages are to be sequenced without turning on and off of compressors to minimize unnecessary wear on the compressors. Upon sensing a call for cooling from the space, the compressors shall provide full cooling until the space sensor is satisfied, upon which time the cooling shall revert to discharge air control. A low discharge temperature set point with a large differential shall be set to prevent the compressor from cycling on and off. The compressor will remain on low setting until cooling is disabled manually or the ambient temperature falls below the minimum set point.

ELECTRICAL CONTROL EQUIPMENT

Electrical assembly and components shall be in strict accordance with the latest provisions and requirements of the National Electric Code. Control cabinet shall be designed and constructed to ETL specifications. A safety disconnect switch shall be mounted on the unit. The controls shall be located in a weatherproof cabinet. Provisions for service padlocking shall be provided. The following items shall be located within the cabinet: fuses, starters, control relays, timing and holding relays, resistors and numbered terminal strips. All components shall be labeled and cross-referenced to control and field wiring diagrams. The control circuit shall be 24V, single phase. Wiring shall be neatly run in "PANDUIT" wiring duct. Low and/or line voltage thermostats shall be furnished shipped loose for installation by others. Unit shall be equipped with automatic low limit freeze protection with bypass timer.

DAMPERS & FILTER SECTION

The dampers are to be galvanized steel (aluminum airfoil low leak) type (with seals). The dampers shall be equipped with 2-position (modulating) actuators. The filters shall be 2" pleated throwaway type with minimum of 85% arrestance and 30% efficiency. Filter access shall be through a latched and gasketed access doors located on both sides of the unit. (Final filters shall be 4 or 12 inch high efficiency cartridge filters.)

REMOTE CONTROL PANELS

Remote NEMA 1(12) locking control panel shall be equipped with summer/off/winter switch and blower on, burner on, flame failure and loaded filter lights. (A remote adjustment potentiometer shall control damper positioning.) (An LCD display shall provide system temperature and set points.)

FLUID COILS

Fluid coils are intended for use with water, glycol, or other appropriate heat transfer fluids. Coils are to be designed to maximize performance under specified conditions with minimal air-side pressure drop.
All water coils designed with 1/2” or 5/8” tubes are to be ARI performance certified and shall bear the ARI symbol.
Tubes and return bends shall be constructed from seamless UNS C12200 copper conforming to ASTM B224 and ASTM E527. Properties shall be O50 light annealed with a maximum grain size of 0.040 mm.
Tubes are to mechanically expanded into fins (secondary surface) for maximum heat transfer. Materials are to be 3/8” diameter x (0.014, 0.022) wall thickness, 1/2” diameter x (0.016, 0.025) wall thickness, or 5/8” diameter x (0.020, 0.025, 0.035, 0.049) wall thickness.
Secondary surface (fins) shall be of the plate-fin design using aluminum or copper, with die-formed collars. Fin design to be flat, waffle, or sine-wave in a staggered tube pattern to meet performance requirements.

Collars will hold fin spacing at specified density, and cover the entire tube surface. Aluminum properties are to be Alloy 1100 per ASTM B209, with O (soft) temper; copper is to be Alloy 11000 per ASTM B152-06 with soft (anneal) temper. Fins are to be free of oils and oxidation.

Headers are to be constructed of seamless UNS C12200, Type L (drawn) copper material sized to match specified connection size. Type K (drawn) copper headers and Schedule 40 steel headers shall be offered as optional materials.

Die-formed copper end caps are brazed on the inside of the headers, unless spun-closed (for sizes up to 1-3/8”). 1/4” vents and drains are to be provided for all fluid coils.

Connection material shall be copper, or Schedule 40 steel or red brass pipe. The type of connection is to be sweat type, MPT or FPT, grooved, or flanged as required.

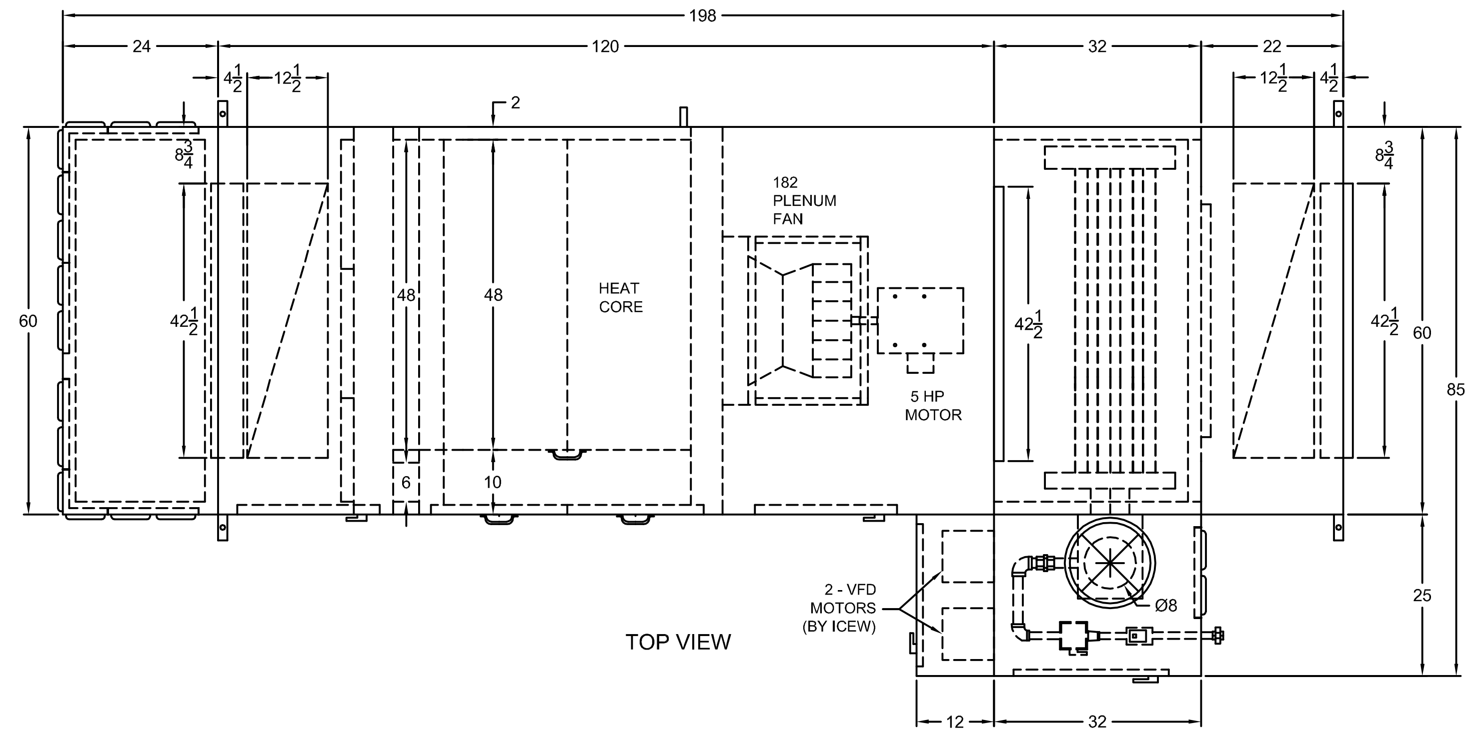
Coil casing material shall be of G90 galvanized steel, 16 gauge minimum. Heavier material, stainless steel, copper, or aluminum casing are to be provided as required.

Intermediate tube supports are to be provided on all coils 48” and longer fin length. Coil casing on top and bottom of coils are to have double-flange construction, allowing for vertical stacking of coils.

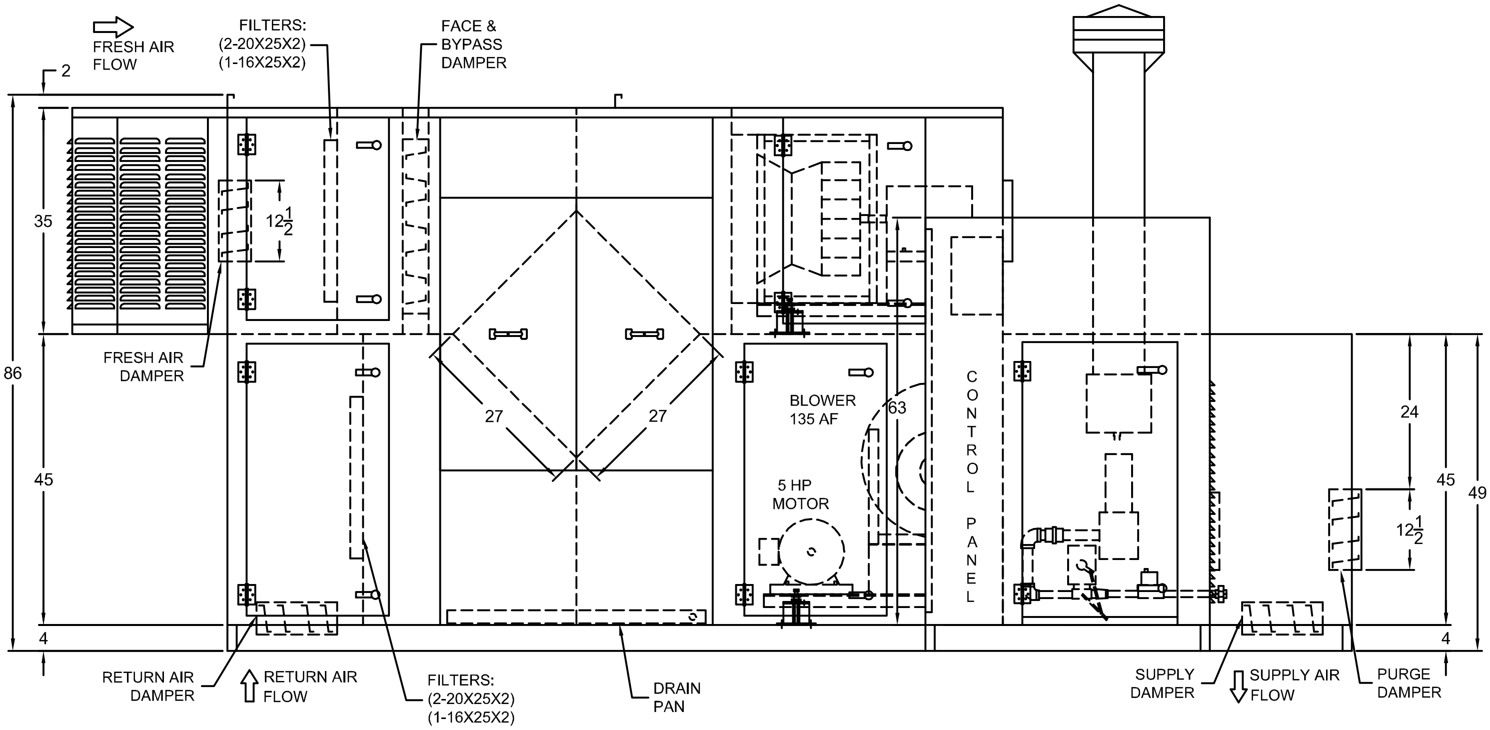
All coils are to be brazed with minimum 5% silver content (BCup-3) filler material to insure joint integrity. Low-fuming, flux-coated bronze braze-weld material is to be used for ferrous to non-ferrous joints.

Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free.

Fluid coils shall be designed to withstand 300ºF maximum operating fluid temperature, and 250 psig maximum operating pressure.



TOP VIEW



SIDE VIEW

NOTES:

1. 1 1/2 INLET AND DISCHARGE FLANGES
2. SERVICE ACCESS PANELS MUST NOT BE OBSTRUCTED RECOMMENDED CLEARANCE 24 INCHES.
3. DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.

FOR REFERENCE USE ONLY, SUBJECT TO CHANGE WITHOUT NOTICE

☐ DRAWING APPROVED
☐ REVISE AS PER NOTED CHANGES AND RESUBMIT

BY: ______________ DATE: ______________

ICE WESTERN
HTDM SERIES

Rev	By	Revision Description	Date

TITLE
TAG: MUA 1-A1-511A, MUA 1-A1-512A
HTDM 400HR HORIZONTAL CONFIGURATION OUTDOOR
c/w FLAT FILTER, MIX BOX, HEAT CORE
AND LOUVERED INLET

DRAWN BY	ISSUED BY	SCALE	DRW. NO.	
JR		1:30	60-27727	
CHK. BY	DATE		JOB NO.	PAGE G-31