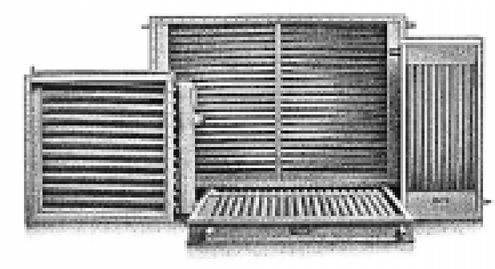


Series 6000 Coils

Heavy-duty steam and liquid heating coils specifically designed for industrial applications requiring strength, durability and high-pressure cleanability.

Armstrong

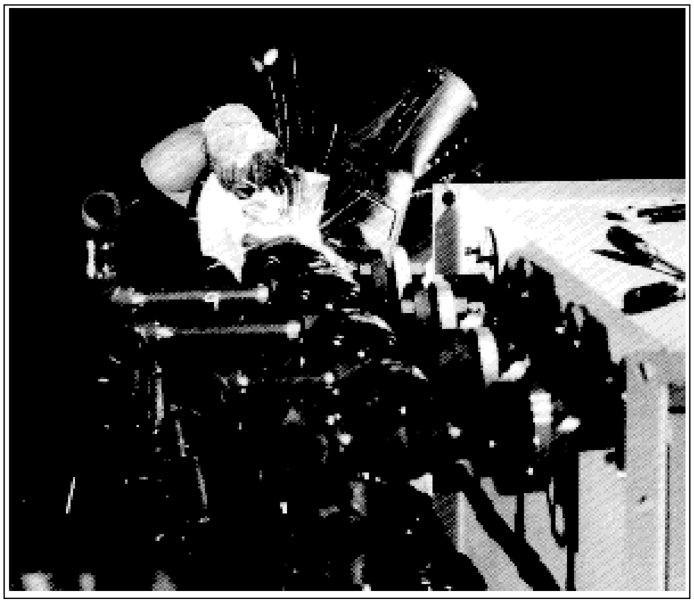
Bringing Energy Down to Earth

Say energy. Think environment. And vice versa.

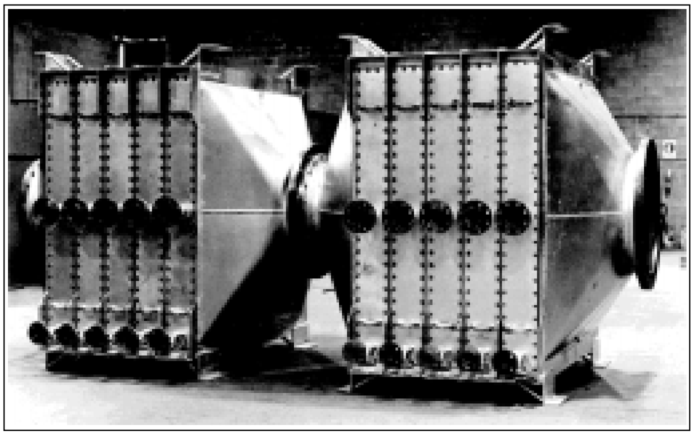
Any company that is energy conscious is also environmentally conscious. Less energy consumed means less waste, fewer emissions and a healthier environment.

In short, bringing energy and environment together lowers the cost industry must pay for both. By helping companies manage energy, Armstrong products are also helping to protect the environment.

Armstrong has been sharing know-how since we invented the energy-efficient inverted bucket steam trap in 1911. In the years since, customers' savings have proven again and again that knowledge *not* shared is energy wasted.



Final fittings are installed on this large, custom-built coil.



Process drying air pre-heaters.

Table of Contents

Why Leaky Coils are a Losing Proposition

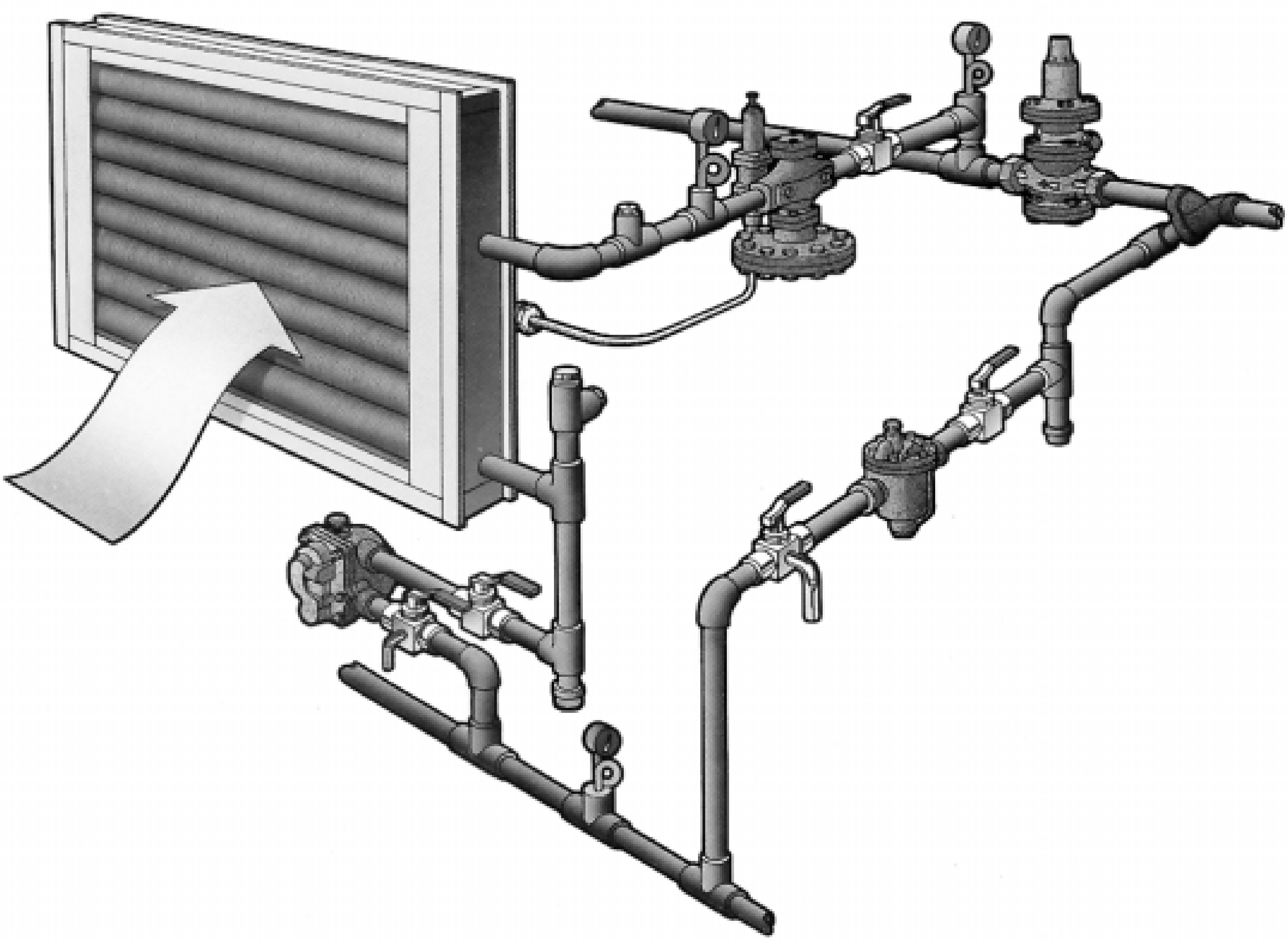
Leaky coils can be the beginning of the end for efficient heat transfer. Although coils may fail for a variety of reasons, mechanical failure and corrosion are the culprits in the majority of cases. When coils corrode, unwanted moisture and contaminants may foul the air stream or exhaust gases. And a steam leak from a badly corroded coil simply blows precious energy off into the atmosphere.

External corrosion. Contaminants in the air stream cause external corrosion. Dirt buildup intensifies corrosive action by trapping contaminants in concentrated pockets. And it's accelerated when dirt becomes strong airborne mist. Factors such as inappropriate fin pitch, fabricating techniques and material selection may also fuel external corrosion.

Internal corrosion. Retention of contaminated condensate or inadequate venting of non-condensable gases are major causes of internal corrosion. When CO_2 gas dissolves in condensate which has cooled below steam temperature, it forms highly corrosive carbonic acid. Likewise, oxygen left to stagnate in the system fosters corrosive action by pitting iron and steel surfaces. Joining pipes/tubes in headers of dissimilar materials may spawn galvanic action. Internal stresses due to improper welding may also hasten corrosion damage.

Armstrong to the Rescue

Armstrong's help in coil selection and design is one of the best defenses against external corrosion. We offer a wide selection of fin pitches to help combat dirt buildup. What's more, sturdy fins lend extra strength to withstand high-pressure cleaning without damage or distortion. As a defense against non-environmental factors, Armstrong fabricates coils in a full range of metals and alloys. You may also specify special coatings to increase external corrosion resistance.



Proper trapping and venting—specialties of your Armstrong Representative—is where defense against internal corrosion begins. Armstrong reps are steam specialists with more than 75 years of experience in properly sizing, locating and piping steam traps, strainers, vents and related equipment. That's why only Armstrong gives you quality steam coils—plus the installation and trapping help you need to make them work in your total system.

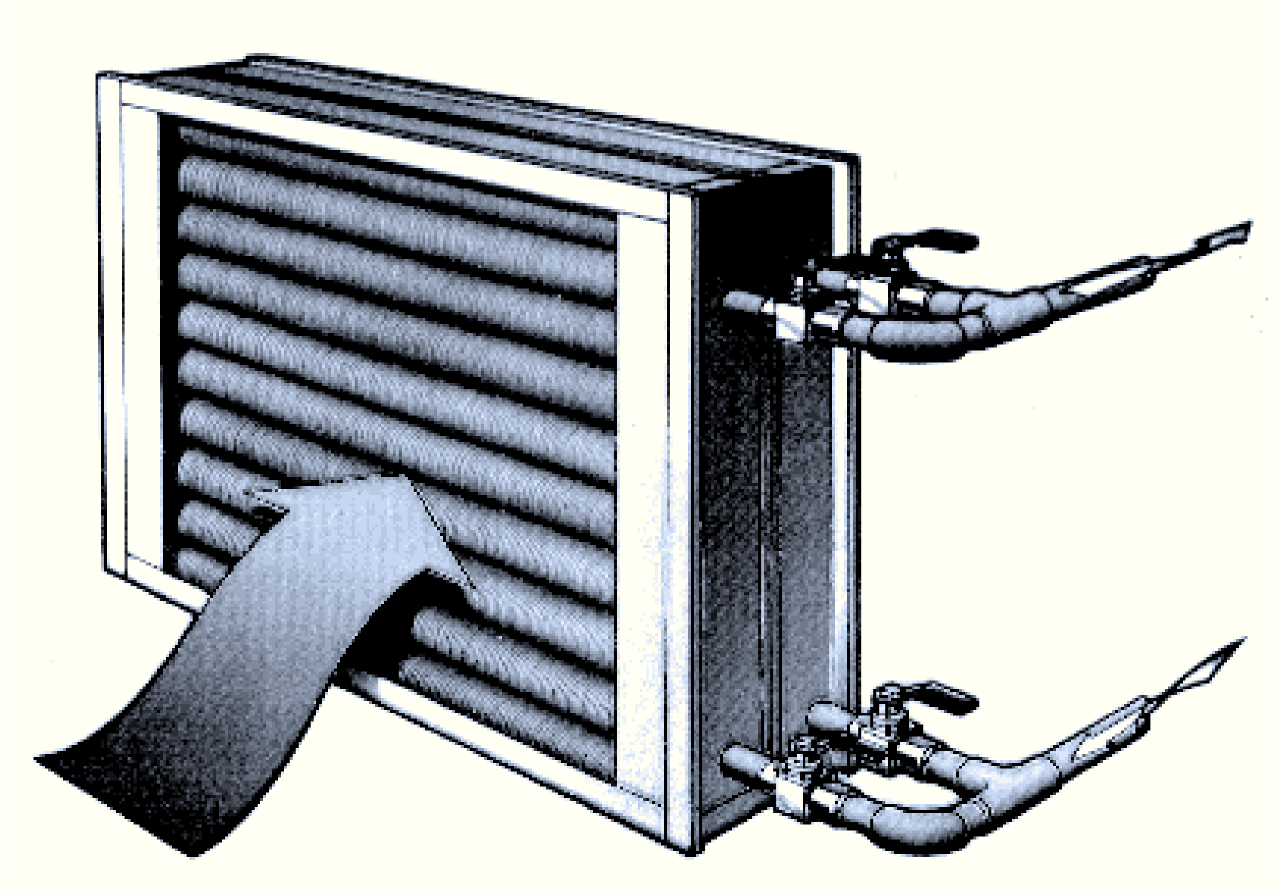
A System to Make Yours More Efficient

Today, the Armstrong "system" merges coil-building experience, practical knowledge and technical know-how from years of trapping coil installations. The result: coils that survive the rigors of high pressures, temperatures and corrosive conditions.

For example, Armstrong fabricates standard steel heating coils from 1" OD 12 ga ERW Tube (.109" wall) helically wound with 0.024" thick steel fins at varying fin pitches.

Each coil is tested during construction, and the completed unit is again tested hydrostatically to not less than 1.5 times the design pressure with a minimum test pressure of 500 psig for steel or stainless steel cores.

It's this simple: It takes one system to improve another. Exactly how the Armstrong system of product and service carefully matches coils to your specs and applications is the subject of the following pages.



Material Selection for Tubes, Headers and Connections

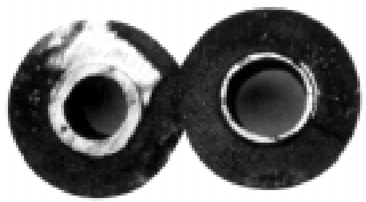
The choice of tube material depends upon several important factors:

- The corrosive quality of the steam or liquid medium.
- The ability to pipe, trap and vent steam coils effectively.
- The size and service requirements of the installation.
- The external corrosion to which the coils are likely to be subjected.

Generally speaking, the heat transfer characteristics of the tube material is of little consequence. Table 7-1 illustrates the relative effect of tube materials on overall heat transfer. Because the fin area constitutes the vast majority of the heat transfer surface, it is the most important factor determining heat transfer effectiveness. Therefore the choice of tube materials should be based on service requirements, not heat transfer efficiency.

Internal corrosion. The base material found in the 6000 Series coils is steel. The minimum wall thickness is .109" for steam coils and liquid coils, which affords both strength and corrosion resistance. All Armstrong coils are of monometallic design, which means that all wetted parts are made of the same materials. This precludes the likelihood of galvanic corrosion often experienced in coils made of dissimilar materials.

For most applications, steel will provide very satisfactory service. In order to do this, however, steam coils must be carefully piped, trapped and vented to ensure good condensate and non-condensable gas evacuation.



The cross section of the coil on the right shows how internal corrosion caused by improper piping, trapping and venting may destroy coils from the inside out.

There are many cases where the steam cannot be conditioned enough to be non-corrosive or it is not possible to pipe, trap and vent the coils properly. For those areas, Armstrong recommends stainless steel wetted parts. Choosing which of these is most appropriate depends on the degree and type of problem as well as the steam pressure involved.

External corrosion. In the case of external corrosion, factors concerning the corrosiveness of the air stream enter into the decision. The choice of steel or stainless steel for the wetted parts depends on the compatibility of those materials with the contaminants in the air stream. In addition to the base materials available, Armstrong also offers hot dipped galvanizing, epoxy powder, baked phenolic or Teflon® coatings. These are frequently used when only external corrosion is a consideration.

Service requirements. These may be as important as the above considerations. Coil failures manifest themselves in many forms, but the most prevalent is failure of the tube-to-header joints. This failure occurs as a result of coil design defects, insufficient material at the tube-to-header joints or because of the method of connecting the tubes to the headers.

Armstrong 6000 Series coils are designed to accommodate the service requirements of the particular installation. They are built with enough material at the tube-to-header joints to make them strong. When differential expansion between tubes in steam coils is likely to over-stress the joints, centifeed type coils are recommended. Finally, Armstrong coils are always of welded construction, providing the best method of connecting the two parts together.

Computer-controlled equipment like this simplifies the process of drilling coil headers.

Tube Materials

The best combination of coil materials is the one that delivers maximum heat transfer **and** service life. Tubes, regardless of material, contribute little to heat transfer in extended-surface coils. It is the *fins,* fully exposed to the air stream, which provide the greatest contribution to heat transfer. Therefore, choose tube material on the basis of application.

Table 7-1. Relative Heat Transfer Capacities of Identical Coils Using Different Tube Materials

Tube Material	Relative HT Capacity
Copper	1.00
Aluminum	1.00
Steel	.98
Stainless Steel	.95

Material Selection for Fins

The heat transfer coil is essentially a tube on which fins are spirally wound or similarly attached. The fins produce an extended surface to improve heat transfer to or from air or other gases passing over the fins. The effective heat transfer of a coil is based on fin pitch (number of fins per inch), fin height, fin material and method of attachment.

Copper fins offer the best heat transfer, but aluminum fins provide the best overall value. Compared to aluminum fins, steel fins reduce heat transfer. Compared to aluminum and steel, stainless steel fins reduce heat transfer significantly. Fins may be of aluminum, copper, steel, or stainless steel, depending on contaminants, operating conditions and economic considerations.

The selection of fin materials should be based upon several considerations:

- The heat transfer characteristic desired.
- The compatibility of the material with the air stream.
- The amount and type of particulate matter in the air stream.
- The frequency and aggressiveness of coil cleaning.

Table 7-2 illustrates the heat transfer effectiveness of various fin materials with Armstrong coils. Note that these relative heat transfer capacities are for a specific set of conditions. The factors will vary with different conditions.

The fin/tube combinations available are listed in Table 9-1.

Table 7-2. Relative Heat Transfer Capacities of Armstrong Coils with Tubes and Fins of Various Materials*

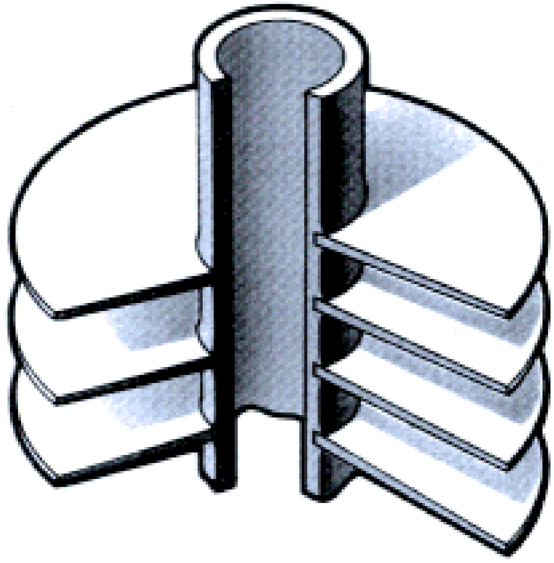
Tube Material	Fin Material	Relative HT Capacity
Steel	Copper Keyfin	1.05
Steel	Aluminum Keyfin	1.00
Stainless Steel	Aluminum Keyfin	.94
Steel	Steel L Fin	.92
Stainless Steel	Stainless Steel L Fin	.58

*At 800 ft/min velocity, 7 fins/inch and 300°F steam temperature. Will vary at other conditions.

Fin Types

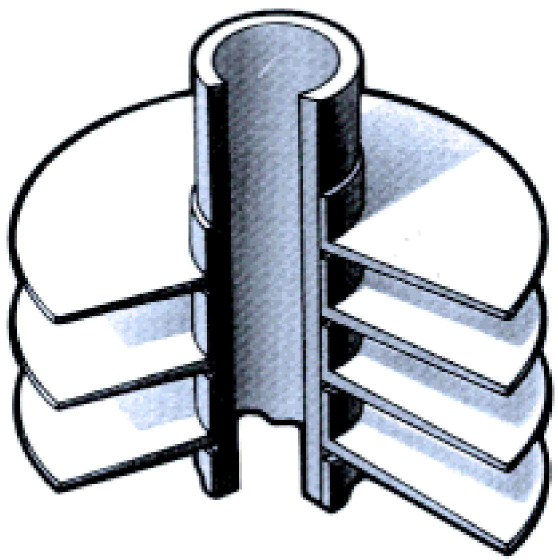
Keyfin

The keyfin is the standard design for Armstrong's most popular coils. Keyfin coils are manufactured by forming a helical groove in the tube surface, winding the fin into the groove and peening the displaced metal from the groove against the fin. This means a tight fit between the fin and the tube, providing for efficient operation over wide temperature ranges. Keyfin is the superior design for dissimilar fin and tube materials.



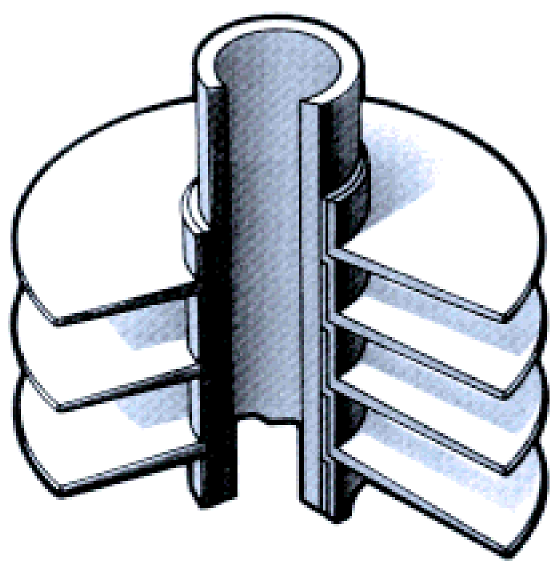
L Fin

The L fin has a "foot" at its base and is tension wound on knurled tube material. The L-shaped base provides a large contact area between the tube and the fin, ensuring effective, long-lasting heat transfer. The L fin is recommended when tubes and fins are of the same material.



Overlap L Fin

The overlap L fin is simply an L fin with an extended base. Each fin overlaps the foot of the previous fin, completely covering the tube surface. The overlap technique makes it possible to create a completely aluminumized coil for applications where exposed steel would be vulnerable to corrosion.



Why Settle for What's "Available"
When You Can Specify Exactly What You Need?

Armstrong manufactures heavy-duty industrial coils in a wide range of sizes and materials to meet virtually any application demand. Dimensionally duplicated to fit your exact requirements, Armstrong coils are what you need. Whether it's off the shelf or off the wall. Other materials will be considered upon request.

Table 9-1. Construction Features

Tubes/Pipes		
Carbon Steel Tubes	Standard	12 ga A-214 ERW
	Optional	10 ga A-214 ERW
		12 ga A-179 Seamless
		10 ga A-179 Seamless
Carbon Steel Pipes	Optional	Sch 80 Seamless; A-106 gr 'B'
Stainless Steel Tubes	Standard	14 ga (1" OD) 12 ga (1 1/2" OD) A-249 Type 304L
	Optional	14 ga (1" OD) 12 ga (1 1/2" OD) A-249 Type 316L
Fins		
Steel	Standard	0.024" Thick on 3/4" NPS Pipes
		0.024" Thick on 1" OD Tubes
		0.036" Thick on 1 1/2" OD Tubes & 1" NPS & Larger Pipe
Aluminum	Standard	0.020" Thick on all Tube Sizes
	Optional	0.030" Heavy Keyfin 1" & 1 1/2" OD Steel and Stainless Steel Tube
Stainless Steel		0.020" Thick Type 304 & 316 on all Sizes
Copper		0.016" Thick on all Sizes
Connections		
Steel		Sch 80 (screwed), Sch 40 (flanged)
Stainless Steel		Sch 40 (screwed), Sch 10 (flanged)
Headers		
All coils have headers of the same material as tubing and are of welded construction.		
Casing		
Galvanized Steel	Standard	Minimum 12 ga Galvanized for Depth 7 1/2" and Over
		Minimum 14 ga Galvanized for Depth Under 7 1/2"
Stainless Steel	Optional	14 ga Type 304 & 316 for all Depths
Aluminum	Optional	12 ga for all Depths
Other gauge material available on request. All casings have drilled flanges for duct mounting unless specified otherwise.		
Design Pressure		
Standard design pressure for steel coils is 250 psig @ 450° F, stainless steel coils 200 psig @ 400° F. Higher pressure and/or temperature construction is available on request.		
Testing		
All coils are tested hydrostatically to at least 1 1/2 times the working pressure with a minimum test of 500 psi on steel & stainless steel steam coils.		
Options		
Steel tube with steel fin coils can be supplied hot dip galvanized. Steel/steel and steel/aluminum coils can be supplied with baked phenolic, epoxy or Teflon® coatings. Coils are available with ASME Section VIII, Division I, "U" stamps or CRN approval.		

Model Number Selection Series 6000 Coils

MODEL NUMBER

S H 2 - A 09 - Q 08 - 30 x 72 x 6 -

TYPE OF COIL

- L ■ Liquid
- S ■ Standard
- C ■ Centifeed
- T ■ Tandem, Opposite-End Conns
- P ■ Tandem, Same-End Conns

PIPE/TUBE/AIR FLOW ORIENTATION

- H ■ Horiz. Tubes/Horiz. Air
- V ■ Vert. Tubes/Horiz. Air
- D ■ Horiz. Tubes/Vert. Down Air
- U ■ Horiz. Tubes/Vert. Up Air

ROWS DEEP IN DIRECTION OF AIR FLOW

FIN TYPE AND METALLURGY

- U ■ Aluminum Keyfin (.016")
- A ■ Aluminum Keyfin (.020")
- B ■ Aluminum Heavy Keyfin (.030")
- D ■ Aluminum G Fin (.020")
- E ■ Aluminum Overlap L Fin (.020")
- F ■ Copper Keyfin (.016")
- G ■ Steel L Fin (.024") on 3/4" NPS Pipe and 1" OD Tube (.036") on 1 1/2" OD Tube
- H ■ Steel G Fin (.024")
- J ■ 304 Stainless Steel L Fin (.020")
- K ■ 316 Stainless Steel L Fin (.020")

LIQUID COILS = NUMBER OF PASSES TH & PH TANDEM STEAM COILS = (L) OR (R) HAND OF COIL*

CASING DEPTH (INCHES)

CASING LENGTH (INCHES)

CASING WIDTH (INCHES)

PIPE NOMINAL BORE SIZE OR TUBE OD IN ONE-EIGHTHS OF AN INCH

PIPE/TUBE TYPE AND METALLURGY

- H ■ 14 ga Steel Tube (A-214 ERW)
- J ■ 14 ga Steel Tube (A-179 SMLS)
- P ■ Sch 80 Seamless Steel Pipe (A-106 Gr B)
- Q ■ 12 ga Steel Tube (A-214 ERW)
- R ■ 10 ga Steel Tube (A-214 ERW)
- S ■ 12 ga Steel Tube (A-179 SMLS)
- T ■ 10 ga Steel Tube (A-179 SMLS)
- W ■ 14 ga 304L SS Tube (A-249)
- X ■ 12 ga 304L SS Tube (A-249)
- Y ■ 14 ga 316L SS Tube (A-249)
- Z ■ 12 ga 316L SS Tube (A-249)

FINS PER INCH (FPI)

SPECIFY:

Number, Size and Type of Connections.

Also call out non-standard items such as:

- **Headers Outside of Casing**
- **Special Casing Flange Width and Drilling**
- **Airtight Casing**
- **Mounting Plate (removable type)**
- **Coatings, etc.**

*Hand of coil is determined by the position of either the condensate connection or the leaving liquid connection when facing the coil with the air flow to your back.

Steam Coils

For air heating coils, steam is the preferred medium for heat transfer throughout much of industry. It affords advantages over liquids because it is easy and inexpensive to move from the boiler to the point of use and because it gives up so much energy at a constant temperature when it condenses. Process control is easily and quickly accomplished with essentially no lag time as is experienced with liquids.

The selection of coil construction and materials is a multi-step process that must take a number of factors into consideration. Armstrong's line of heavy-duty steam coils is designed and manufactured to provide the long life and efficient heat transfer that pays dividends over a long period of time.

Selection of Steam Coil Circuitry

Pages 12 and 13 show the four types of coil circuits offered by Armstrong and discuss the application parameters of each. The return bend type circuit is not covered because Armstrong feels that one of the four listed circuits is a better choice for most applications.

Armstrong can build coils to a wide variety of material and performance specifications and dimensionally duplicate replacement coils to fit your exact requirements.

Series 6000 Steam Coil Types

Standard Coils (Type S)

This type of coil is used for most applications where entering air temperatures are above 35°F and steam is at constant pressure. It is used extensively in high-temperature process applications and for "reheat" in HVAC systems. It is not, however, recommended where even outlet air temperatures are required immediately after the coil such as in multi-zone heating systems, or where a modulating steam control valve is used to control temperature.

Type S coils are available with opposite-end connections only.

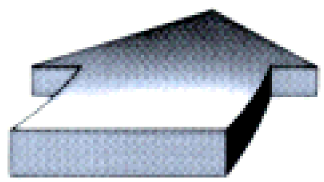
Centifeed Coils (Type C)

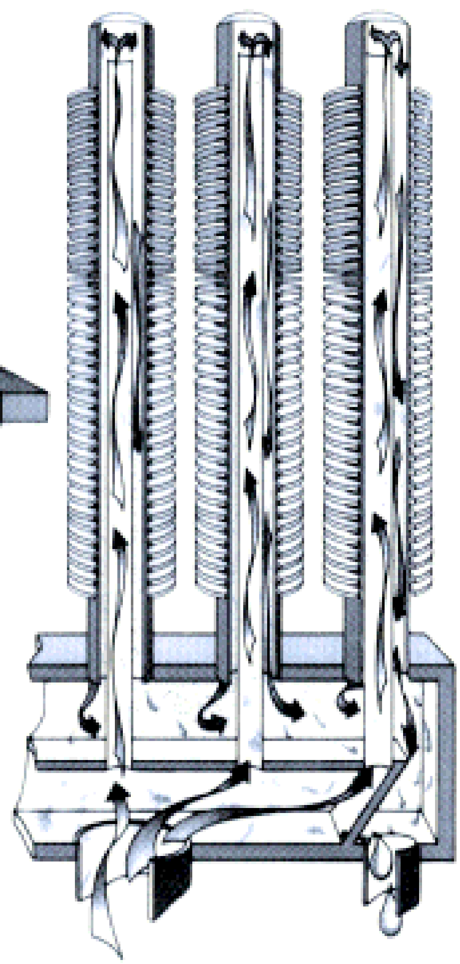
The single-row centifeed coil can be used where air is below freezing and/or modulating control is used. Recommended where:

A A single row delivers the required performance.
B A modulating steam control valve is used.
C Even outlet air temperatures are required over the whole coil face.
D Stainless steel tubes are used.

Two-row centifeed coils are available where (b) and (c) are required, but tandem type coils are a better choice with freezing air temperatures.

A centifeed coil is one plain tube—called the inner steam distribution tube—inserted inside an outer finned tube. The center tube is fed with steam which travels up this distribution tube and is then discharged into the outer tube. It then travels back between the outside wall of the distribution tube and the inside wall of the finned tube to the condensate header. The inner tube acts as a steam tracer to keep the finned tube warm along its total length.





Type C coils are available with same-end connections only.

Tandem Coils (Types T and P)

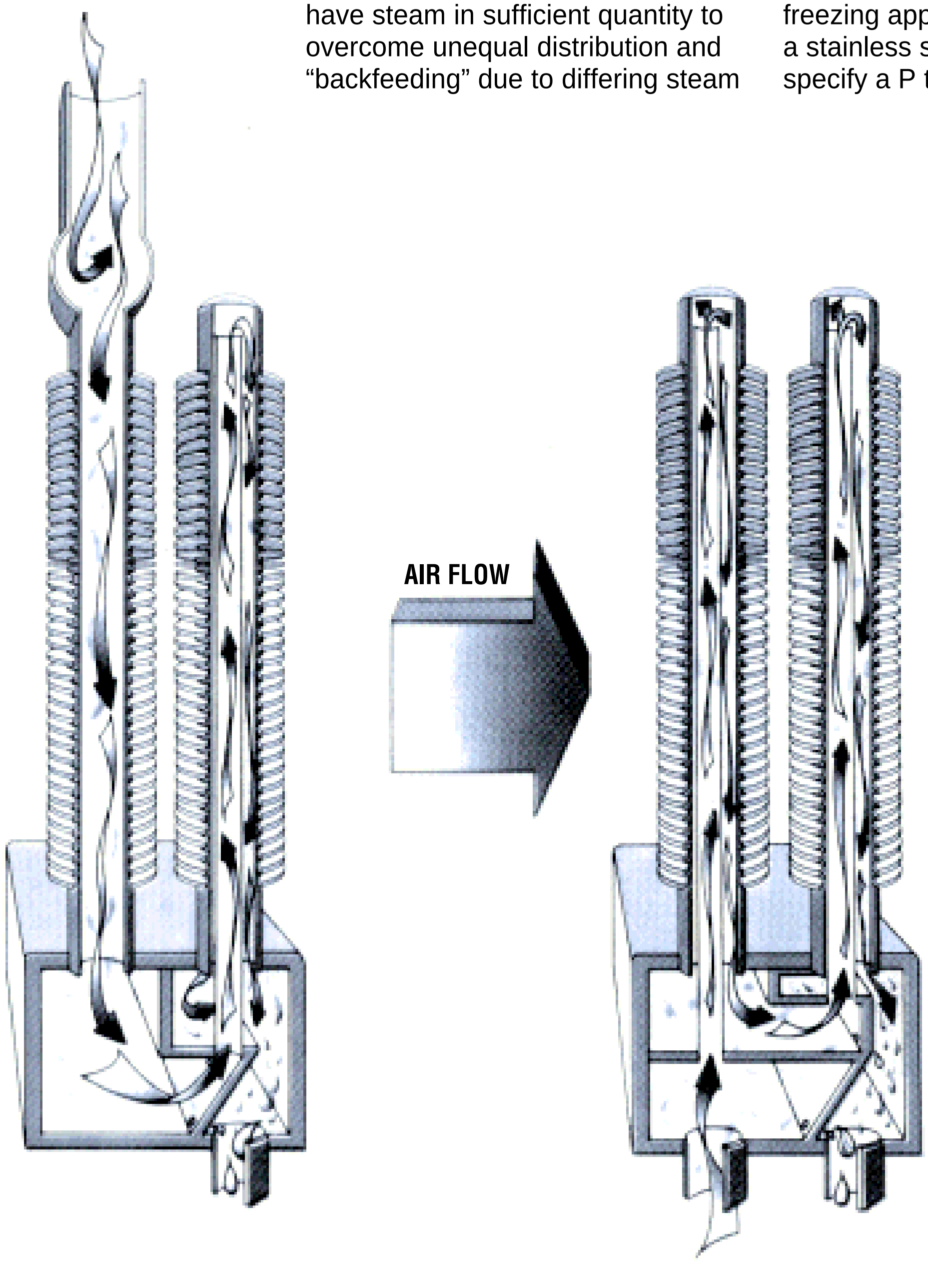
Freezing applications requiring more than one row to achieve the desired final air temperature demand this type of coil.

The coil is designed so that the total amount of steam to be condensed by the whole coil is fed into the first row in the direction of air flow.

This purges non-condensable gases and droplets of condensate from that part of the coil exposed to the coldest air. Channeling the steam from the header to the other rows in series has the same purging effect. This design ensures that air passing over the last row is at least 35°F.

The coldest part of the coil will always have steam in sufficient quantity to overcome unequal distribution and “backfeeding” due to differing steam loads and pressure drops in adjacent tubes. This eliminates freezing problems caused by condensate holdup.

The “series” feed characteristic of the tandem coil, as opposed to the “parallel” feed of the two-row centifeed coil, makes it the ideal choice for multi-row coils in freezing applications. If you want a stainless steel tube tandem, specify a P type.

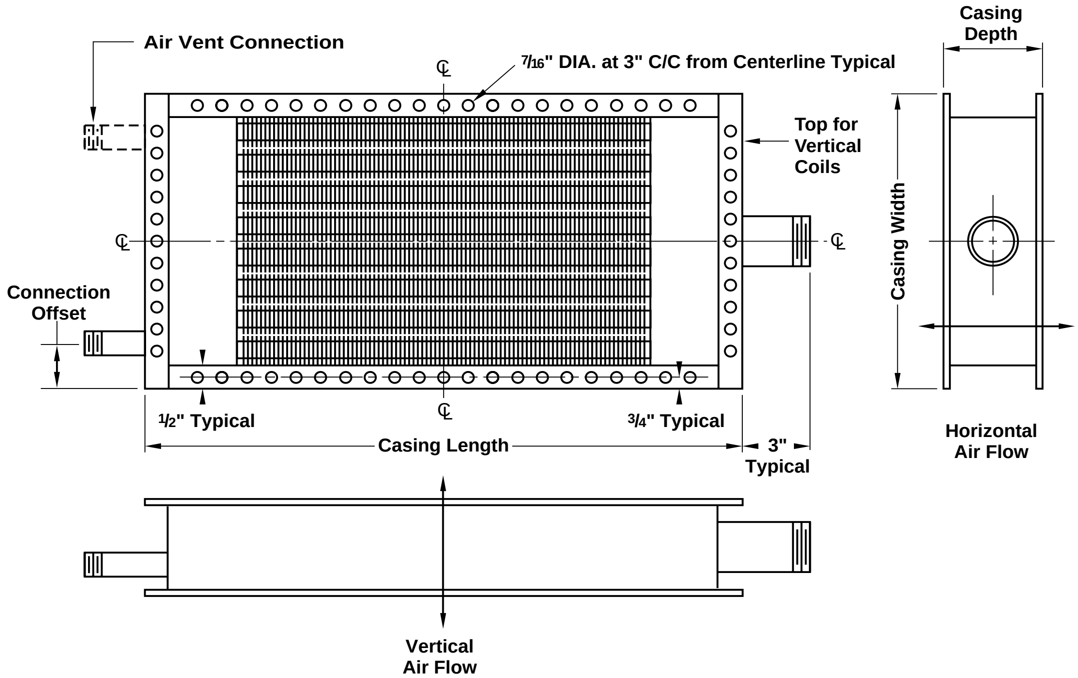


Type T coils have opposite-end connections.

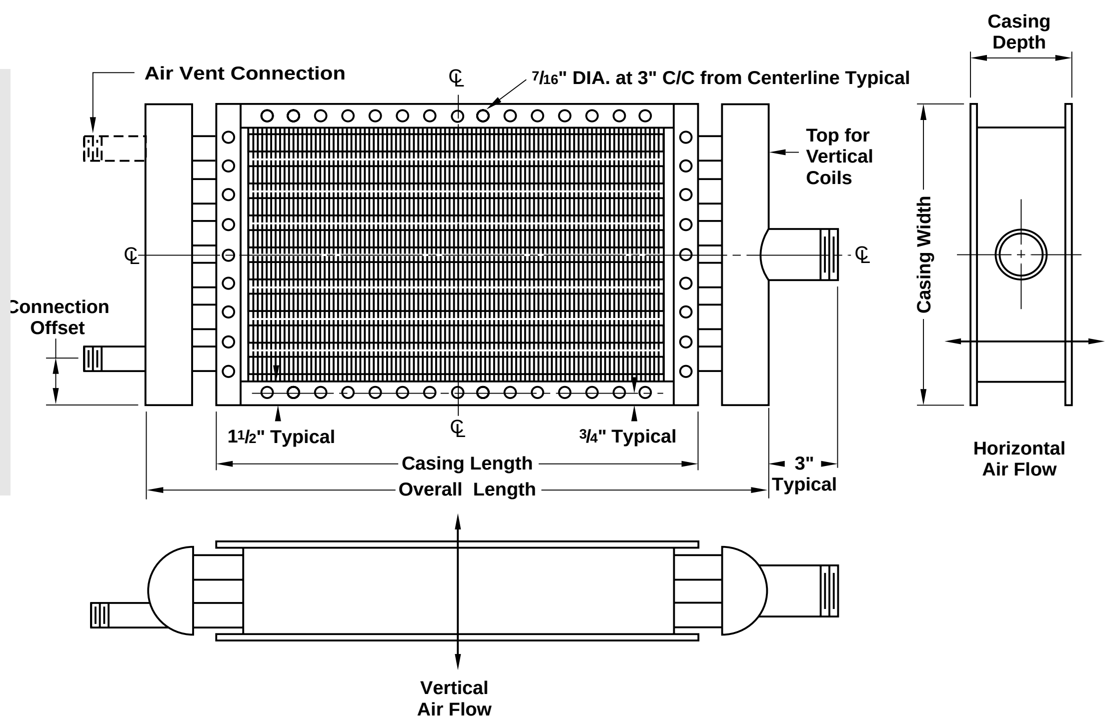
Type P units have same-end connections.

Steam Coil Typical Arrangements

- Standard Coils (Type S)
- Tandem Coils (Type T)
- For Vertical or Horizontal Air Flow
- With Headers Inside the Casing



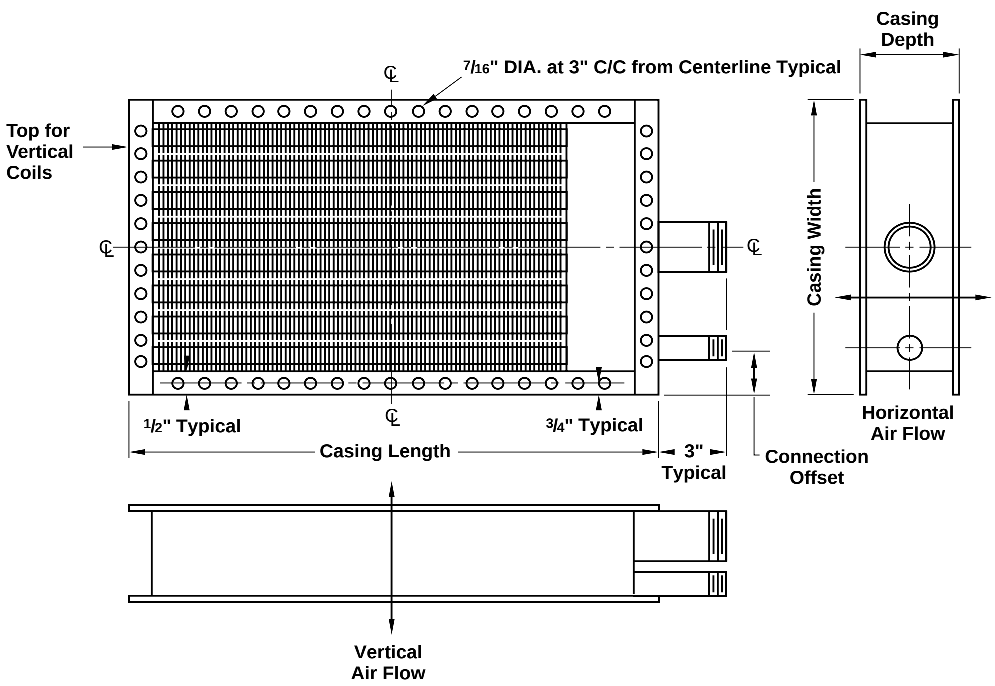
- Standard Coils (Type S)
- Tandem Coils (Type T)
- For Vertical or Horizontal Air Flow
- With Headers Outside the Casing



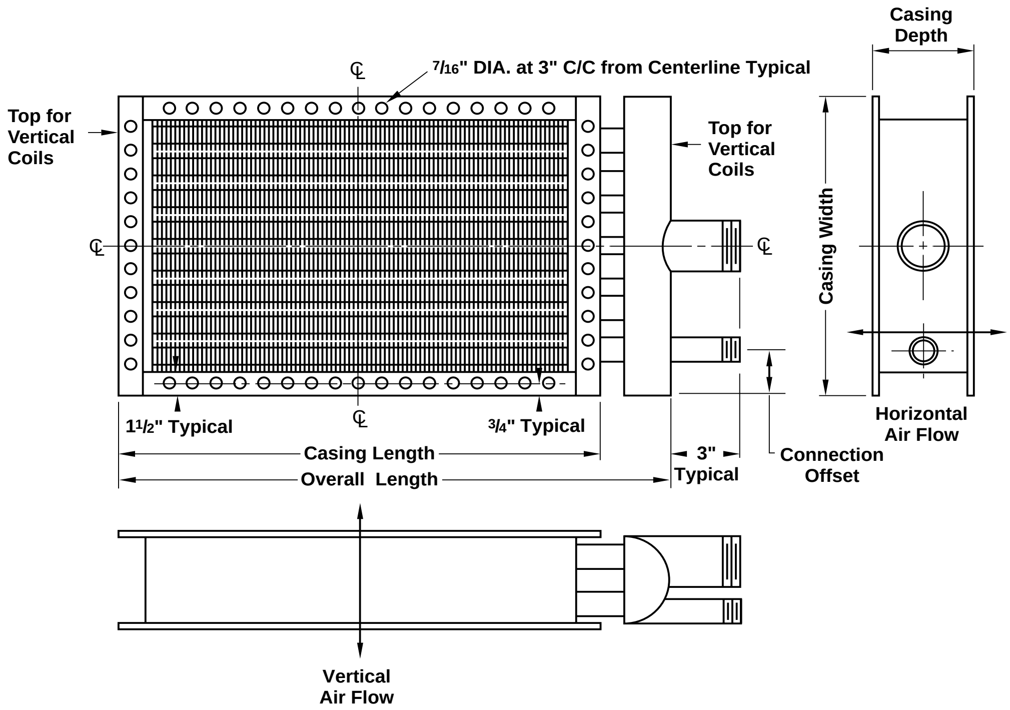
NOTES: Always specify air flow directions and tube orientation when ordering coils.
Specify all dimensions for replacement coils, especially those varying from typicals above.
If coils are to be Tandem type, specify coil hand by facing the coil with air flow at your back and point to the condensate connection.

Steam Coil Typical Arrangements

- Centifeed Coils (Type C)
- Centifeed Tandem Coils (Type P)
- For Vertical or Horizontal Air Flow
- With Headers Inside the Casing



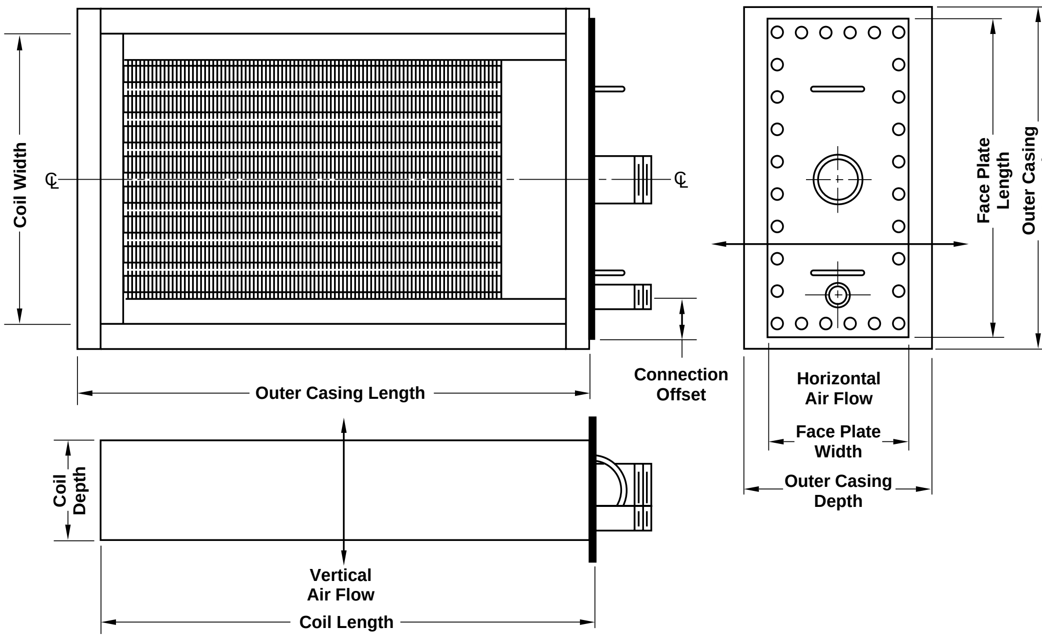
- Centifeed Coils (Type C)
- Centifeed Tandem Coils (Type P)
- For Vertical or Horizontal Air Flow
- With Headers Outside the Casing



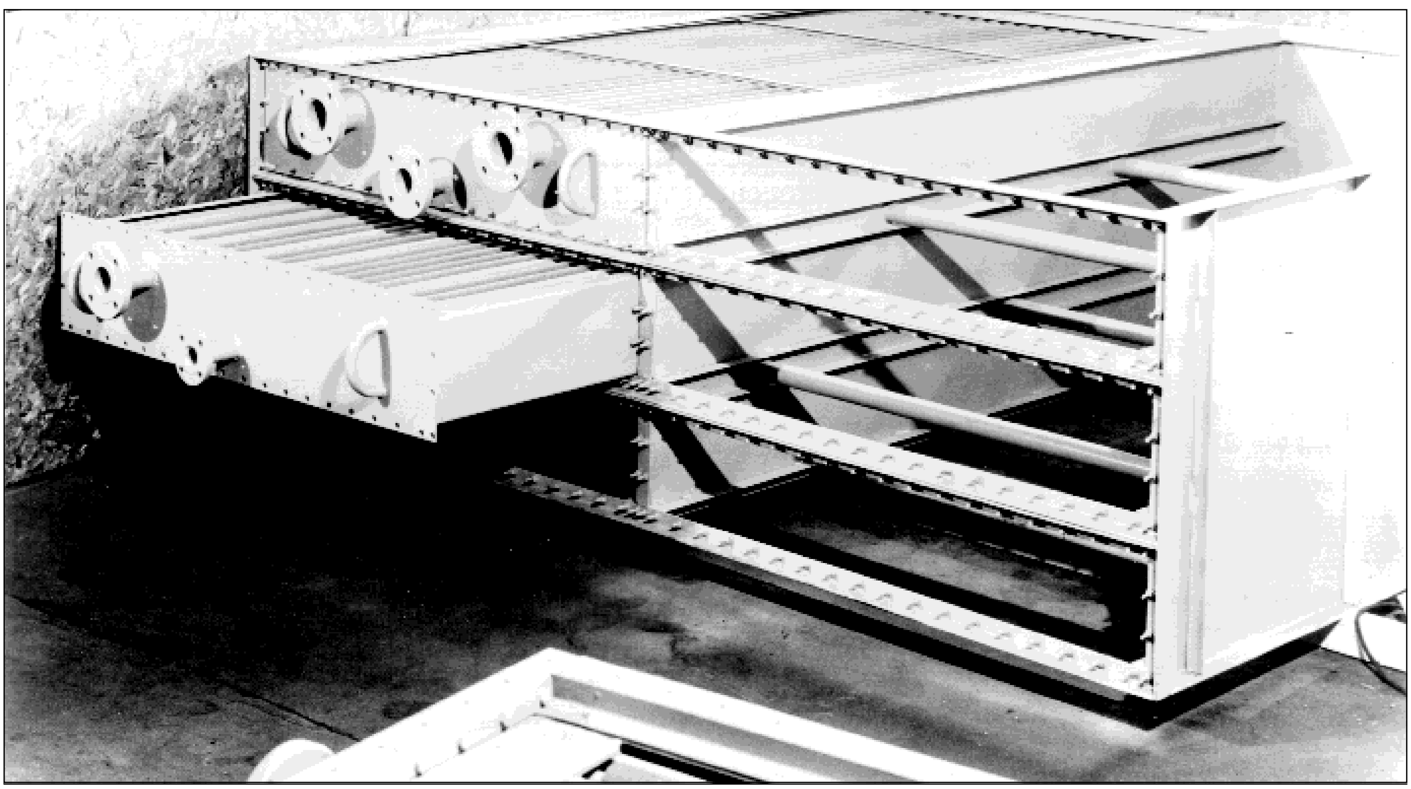
NOTES: Always specify air flow directions and tube orientation when ordering coils.
Specify all dimensions for replacement coils, especially those varying from typicals above.
If coils are to be Tandem type, specify coil hand by facing the coil with air flow at your back and point to the condensate connection.

Steam Coil Typical Arrangements

- Removable Coils
- Centifeed Coils (Type C)
- Centifeed Tandem Coils (Type P)
- For Vertical or Horizontal Air Flow
- With Headers Inside the Casing

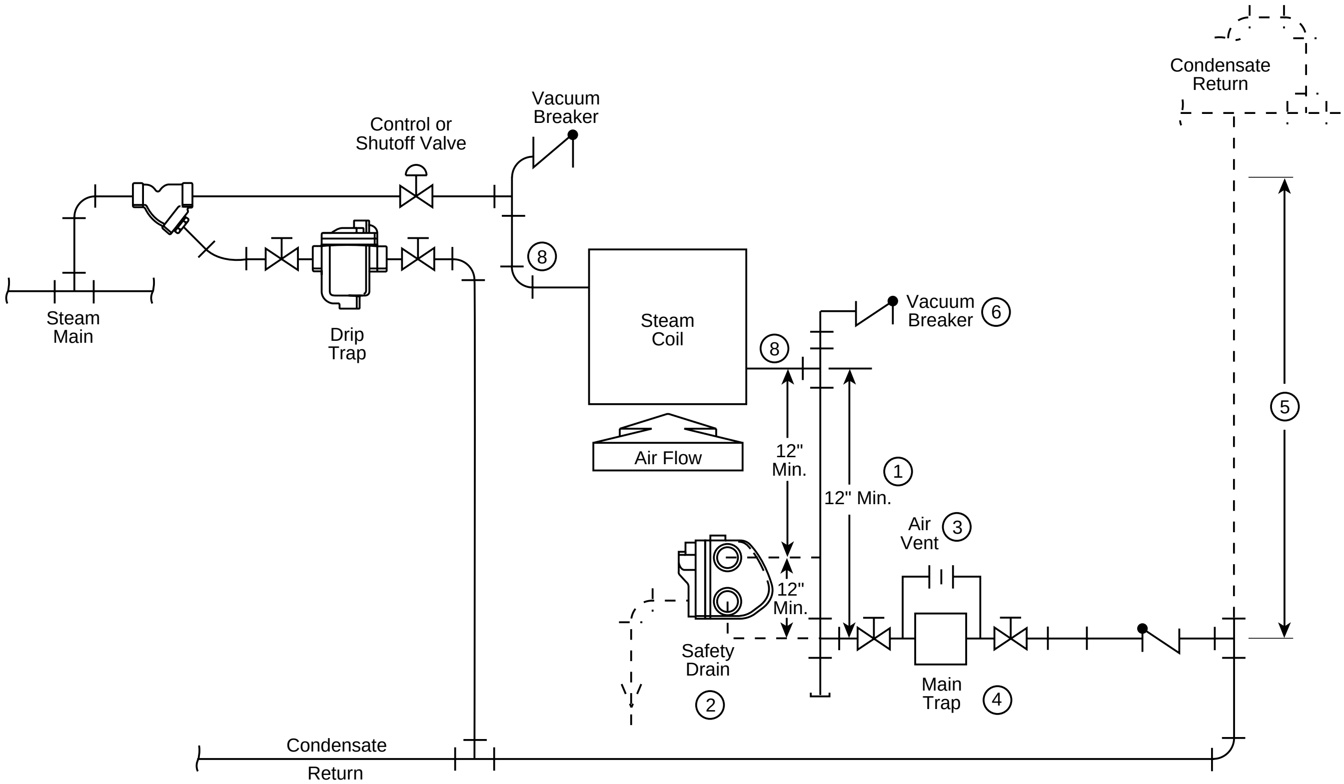


NOTES: Always specify air flow directions and tube orientation when ordering coils.
Specify all dimensions for replacement coils, especially those varying from typicals above.
If coils are to be Tandem type, specify coil hand by facing the coil with air flow at your back and point to the condensate connection.
Removable coils can be designed for removal from either connection end or end opposite connections.



Removable coils with outer casing.

Recommended Piping Practices for Steam Heating Coils



NOTES:

1. 24" minimum if safety drain is used.
2. Safety drain is used if steam supply is modulated and the condensate system is pressurized or overhead. Armstrong's pumping traps or Posi-Pressure Control system provides additional protection or may substitute for the safety drain, especially if condensate conservation is desired.
3. Air venting must be provided on all steam coils except those using low-pressure Posi-Pressure Control systems. The air vent may either be an orifice bleed or a thermostatically operated element, with the orifice bleed being the preferred choice. The air vent or orifice bleed should be piped so that it cannot be valved out independently of the trap.
4. The main trap may be either an Inverted Bucket or a Float & Thermostatic type depending upon the service conditions. See the chart below for recommendations. Inverted bucket type steam trap required with Posi-Pressure Control system.
5. Overhead condensate return system.
6. Required only on a modulated system.
7. See Bulletin A-H 825 for detailed operation and maintenance procedures.
8. Provide a flexible connection or swing joint at the coil inlet and outlet connections to isolate the coil from vibration, piping stresses and differential expansion within the coil.

Table 17-1. Armstrong Steam Trap Selection Guide

Equipment	Selections	Constant Pressure		Modulated Pressure	
		0-30 psig	Above 30	0-30 psig	Above 30
Unit Heaters	1st Choice	IBLV	IBLV	F&T	F&T
	2nd Choice	F&T	F&T	IBLV	IBLV
Air Handlers	1st Choice	IBLV	IBLV	F&T	F&T
	2nd Choice	F&T	F&T	IBLV	IBLV
		0-250 psig	Above 250	0-30 psig	Above 30
Process Coils	1st Choice	IBLV	IBLV	F&T	F&T
	2nd Choice	F&T	IBLV	IBLV	IBLV

Installation, Operation and Maintenance Instructions

In steam coils, successful operation and a long, trouble-free service life depend on:

1. The manner of installation, including the design of coil mounting and piping—with particular emphasis on trapping and air venting.

2. Operating conditions which are within design parameters.

3. The method of operation.

4. The thoroughness and frequency of cleaning required.

Following these simple guidelines will help you achieve maximum coil performance.

Receipt and Storage

1. Upon receipt, inspect coils and notify carrier immediately of any damage sustained in transit.

2. If coils are not installed immediately, store under cover in a heated area free of potential damage from personnel and/or equipment.

Installation

1. **Support coils and piping individually** to prevent undue strains on the steam and condensate connections. Use swing joints or flexible connections for freedom of movement.

2. Steam and condensate pipes should be the same size as coil connections. Maintain connection size from the coil back to the steam main and from the coil to the steam trap takeoff.

3. **Install a drip trap** prior to the coils (and before a control valve if there is one) to prevent the introduction of condensate.

4. **Install strainers with blowdown valves** before all control valves and traps.

5. To avoid hunting and maintain control, use only modified linear or equal percentage (vee-port) valves when a modulating control valve regulates the steam supply. Consult Armstrong for proper applications.

6. **Never oversize control valves. Bigger is *not* better.**

7. **Install a vacuum breaker** in the steam piping prior to the coil to prevent retention of condensate during shutdown. Also install a vacuum breaker on the downstream side of the coil when steam pressure is to be modulated. If you use check valves as vacuum breakers, they should be 15-degree swing checks.

8. Provide venting of non-condensable gases individually on each coil to ensure maximum heat transfer and minimum internal corrosion. In order of effectiveness, venting can be with a fixed orifice bleed, independent thermostatic vent or by using a float and thermostatic steam trap.

9. Trap all coils individually. Locate trap as close to coil as possible. Otherwise, inadequate drainage may damage the coil and/or interfere with effective heat transfer.

10. Use only traps such as the inverted bucket or float and thermostatic which drain continuously. When steam to the coils is modulated, a float and thermostatic trap is preferred. See Table 17-1 for selection guidelines.

11. **Install a dirt pocket** prior to the steam trap. You may also install a gate valve at the bottom of the dirt pocket to facilitate drainage during shutdown periods.

12. Use the same size trap on all coils when they are in parallel across the duct opening. Coils mounted in series (one behind the other in the direction of the air flow) typically have lower condensing rates at the downstream end of the system. Size traps to handle the maximum calculated load for individual coils. Avoid oversizing. Consult your Armstrong Representative if you need assistance.

13. Modulating control valves are best used with gravity flow vented condensate return systems. If the condensate return system is overhead or pressurized, the use of pumps, Armstrong pumping traps or the Armstrong Posi-Pressure Coil Controller System is highly recommended. If this is not possible a safety drain as illustrated on page 17 should be installed.

14. **Install filters** at the coil inlet if possible. Simple filter systems permit easy cleaning or replacement and ensure efficient operation.

15. Refer to page 17 for an illustration of piping practices for steam heating coils.

Operation

Once coils are installed properly, their performance and service life depend on a few simple guidelines for maintenance and operation.

1. To prevent plugging of tubes, clean the piping system and blow down all strainers prior to initial startup.

2. On startup, feed steam to the coils slowly to avoid thermal shock loadings.

3. Make sure the steam has been on for a minimum of 15 minutes prior to starting fans or opening dampers.

4. Make sure operating pressures are kept within design limits.

5. During initial startup, tighten all bolted connections once the system stabilizes at operating temperature.

6. To provide maximum freeze protection, maintain a minimum steam pressure of 5 psig to coils exposed to air temperature below 40°F (5°C). If this is impossible, consult your Armstrong Representative.

7. Drain during shutdown to prevent internal corrosion.

Maintenance

1. If filters are installed, clean regularly to maintain adequate air flow across the coils and to keep fan loadings at design.

2. If filters are not used, inspect and clean coils periodically. Clogged filters and plugged coils have the same result.

Liquid Coils

Although steam may be the most preferred heating medium for coils, liquids such as water, glycol solutions and high temperature heat transfer fluids are coming into wide use. Some of the reasons for the popularity of water and glycol systems are:

- Heat recovery systems are becoming more popular, and hot water or glycol solutions are ideal for that duty.
- Hot water may be readily available from such sources as condensate systems or other processes, and it makes sense to use the available heat from those sources.
- Users have a preference for liquids over steam.

The use of high temperature heat transfer fluids has a number of practical advantages over water and steam when process air has to be heated to high temperatures. These fluids can operate in the 500°F to 750°F range at or near atmospheric pressure as opposed to steam which would have to be over 1,500 psig in order to achieve a saturation temperature of 600°F.

Systems capable of operating at high pressures are expensive to construct and maintain. Corrosion caused by steam and water and the need for water treatment to minimize scale formation result in high maintenance costs. The absence of any need for supervisory staff to be on constant duty is a further advantage of the high temperature heat transfer fluid system.

To meet the needs of industry for heavy duty liquid coils, Armstrong has introduced a line of standardized sizes in seven widths from 16 3/4" to 57 3/4" in 21 lengths from 24" to 144". These are available with fin pitches from 5 to 11 FPI and in 2 or 3 rows. Many circuiting options are available.

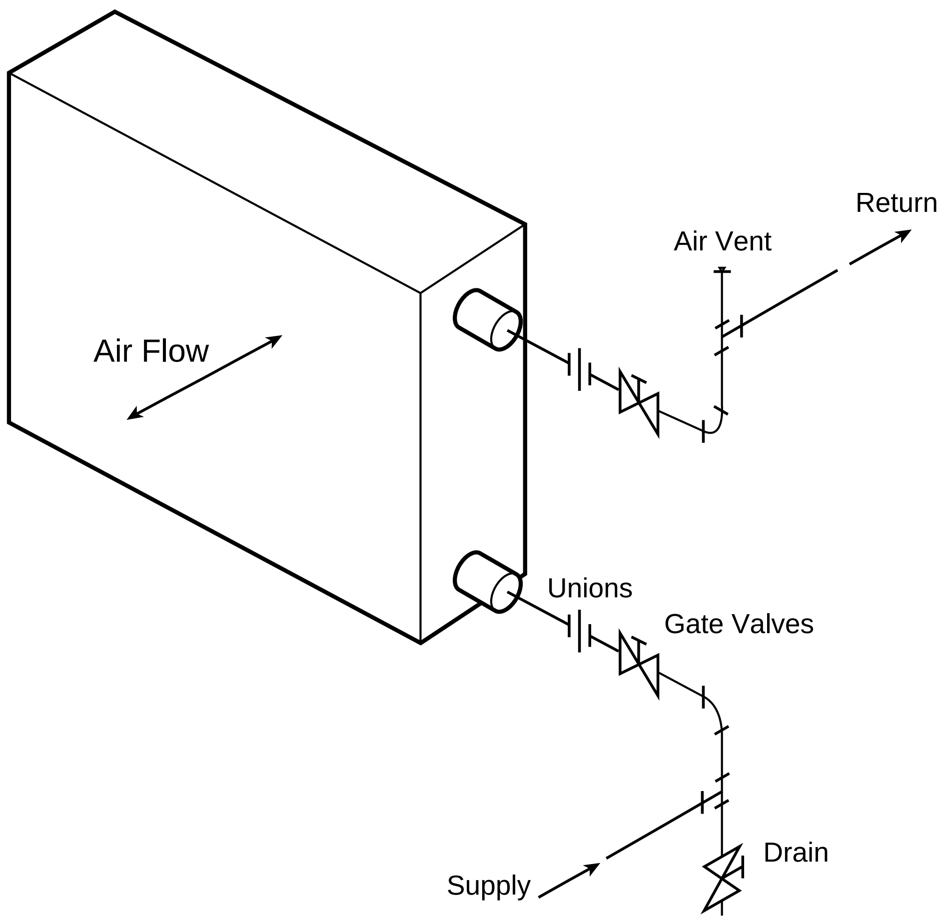
As with all Armstrong coils, liquid coils are built to withstand the rigors of tough industrial applications in contrast to the commercial grade coils frequently misapplied in industrial environments.

In addition to the standardized line, custom coils in sizes to fit existing installations and in materials to fit particular applications are also available.

Materials of Construction:

Tubes	1" OD, 12 ga (.109" wall thickness) A-214 ERW carbon steel tubes (seamless tubes optional)
Fins	.020" or .030" thick aluminum keyfin (imbedded)
Headers	Schedule 40 steel or fabricated
Connections	Water and glycol solutions: ▪ Schedule 80 steel screwed MPT (flanges optional)—same end. High temperature heat transfer fluids: ▪ Seamless Schedule 40 steel with 300 lb raised face weld neck flanges—same end.
Assembly	All wetted parts are welded into a monometallic structure, affording the greatest strength and corrosion resistance.
Design	250 psig at 750°F. Hydrostatically tested to 500 psig.
Casing	Minimum 14 ga galvanized steel primed after manufacture.
Coatings	Special coatings such as baked phenolic, epoxy powder and Teflon® are available as options. These coatings are suitable for temperatures up to 400°F.

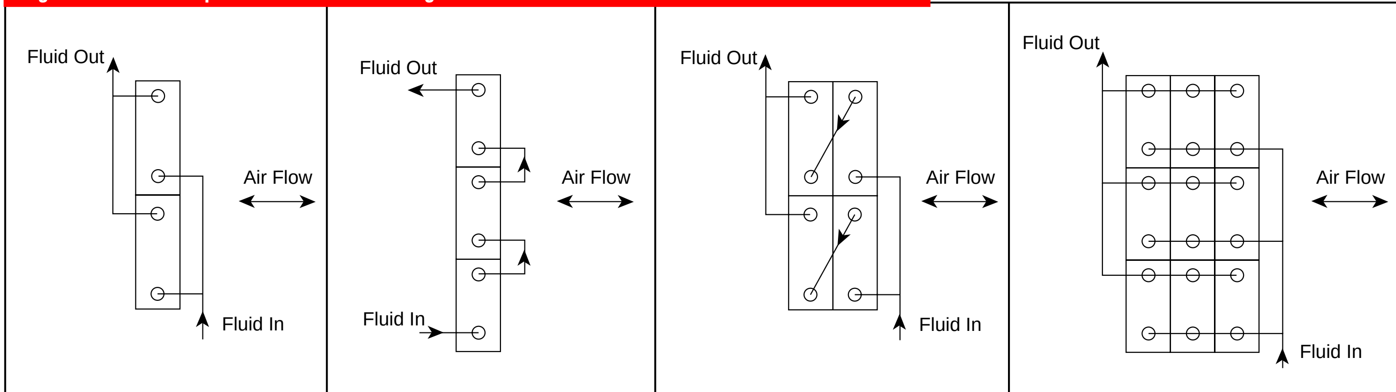
Figure 20-1. Piping Diagram for Water and Ethylene Glycol



1. Install coils level to assure complete drainage.
2. Supply water to the bottom connection and return through the top connection.
3. Carefully vent coils, either individually or through an air manifold.
4. Armstrong recommends that coil isolation valves be fitted to take out coils without disturbing the whole system.
5. Ensure that water supply to coils is as clean as possible to avoid potential blockage and excessive fouling. Settling tanks and strainers can be used for this purpose.
6. Do not support piping from the coils. Install adequate hangers and expansion joints to prevent undue stresses.
7. Armstrong recommends the use of low pressure air or flushing with ethylene glycol to prevent freeze damage when draining.
8. Do not use throttling controls in hot water heating service if there is a possibility of below-freezing air passing through the coil. Use an air by-pass system at full water flow rate for control.

NOTE: Keep finned tube surface clean and free of all foreign matter in order to maintain the design heat transfer and pressure drop ratings. Install filters upstream of the coils to keep actual coil maintenance to a minimum.

Figure 21-1. Examples of Multi-Coil Arrangements



Air Flow: 2 in Parallel **Fluid Flow: 2 in Parallel**	**Air Flow: 3 in Parallel** **Fluid Flow: 3 in Series**	**Air Flow: 2 in Parallel x 2 in Series** **Fluid Flow: 2 in Parallel x 2 in Series**	**Air Flow: 3 in Parallel x 3 in Series** **Fluid Flow: 9 in Parallel**

Table 21-1. Useful Conversions

	Multiply	By	To Obtain
Length	mm	0.039370	in
	m	3.2808	ft
	in	0.083333	ft
	in	25.400	mm
	ft	12.000	in
	ft	0.30480	m
Area	m^2	10.764	ft^2
	cm^2	0.15500	in^2
	in^2	0.0069444	ft^2
	m^2/m	3.2808	ft^2/ft
	ft^2/ft	0.30480	m^2/m
	ft^2	0.092903	m^2
Volume	m^3	35.315	ft^3
	in^3	0.00057870	ft^3
	ft^3	0.028317	m^3
	gal(US)	0.13368	ft^3
	gal(IMP)	1.2009	gal(US)
	litre	0.26417	gal(US)
Mass	kg	2.2046	lb
	lb	0.45359	kg
Pressure	Pa	0 .0040147	in of water
	kPa	4.0147	in of water
	kPa	0.33456	ft of water
	kPa	0.14504	lbf/in^2 (psi)
	kPa	0.29530	in of Hg
	mm of water	0.039370	in of water
	in of water	0.24908	kPa
	in of water	0.036126	lbf/in^2
	in of water	0.0024582	atmospheres
	ft of water	2.9890	kPa
Velocity	m/s	3.2808	ft/s (fps)
	m/min	3.2808	ft/min (fpm)
	mi/hr (mph)	1.4667	ft/s
	ft/s	0.30480	m/s
	ft/min	0.016667	ft/s

	Multiply	By	To Obtain
Mass Flow	kg/s	7936.6	lb/hr
	kg/hr	2.2046	lb/hr
	lb/s	3600.0	lb/hr
	lb/hr	0.45359	kg/hr
Volume Flow	m^3/s	2118.9	ft^3/min (cfm)
	ft^3/s	60.000	ft^3/min
	ft^3/min	0.00047195	m^3/s
	litre/s	15.850	USGPM
	USGPM	0.063092	litre/s
Density	kg/m^3	0.062428	lb/ft^3
	g/cm^3	62.428	lb/ft^3
	lb/in^3	1728.0	lb/ft^3
	lb/ft^3	16.018	kg/m^3
Specific Heat	kJ/kg °C	0.23885	Btu/lb °F
	kcal/kg °C	1.0000	Btu/lb °F
	Btu/lb °F	4.1868	kJ/kg °C
Energy	kJ	0.94782	Btu
	kWhr	3412.1	Btu
	kcal	3.9683	Btu
	ft lbf	0.0012851	Btu
	hp hr	2544.4	Btu
	Btu	1.0551	kJ
	Btu	0.0002931	kWhr
	Btu	0.25200	kcal
	J	0.00027778	W hr
Power	W	3.4121	Btu/hr
	kcal/hr	3.9683	Btu/hr
	ft lbf/hr	0.0012851	Btu/hr
	hp	2544.4	Btu/hr
	Btu/hr	0.29307	W
	Btu/hr	0.25200	kcal/hr
Heat	kJ/kg	0.42992	Btu/lb
	Btu/hr	2.3260	kJ/kg

Temperature

1.8C + 32 = F
(F - 32)/1.8 = C
C + 273.15 = K
F + 459.69 = R

Fin Spacing

FPI = 25.4/mm Pitch
mm Pitch = 25.4/FPI

Metric Equivalents

Pa = N/m^2 = kg/s^2 m
N = kg m/s^2
J = Ws
Liter = dm^3
kp = kgf
kp/m^2 = mm of water
Bar = 100 kPa
Bar = 100 kPa
Centipoise = m Pa.s

How to Specify Armstrong Series 6000 Steam Coils

Heavy-duty construction/fabrication is why Armstrong Series 6000 coils last longer, saving maintenance and frequent replacement costs.

Think about it. Less expensive coils are also *less durable* and are commonly misapplied in heavy industrial service. As a result, they actually become *more expensive* when measured by downtime, maintenance and replacement over a period of time. It's really a very simple fact: Higher initial costs are justified when they secure a lower life cycle cost.

The sample specifications below will help you in detailing coil construction for your heavy-duty application. These samples cover the most popular of the various material combinations. For assistance with other options, consult your Armstrong Representative.

Steel Tube/Aluminum Keyfin

- Tubes—minimum 12 ga carbon steel
- Fins—minimum 0.020" thick aluminum (imbedded type)
- Headers—minimum Sch 40 carbon steel pipe
- Connections—minimum Sch 80 carbon steel pipe
- Casings—minimum 14 ga galvanized steel
- Tubes, headers and connections shall be welded together to form monometallic joints.

Steel Tube/Steel Fin

- Tubes—minimum 12 ga carbon steel
- Fins—minimum 0.024" thick carbon steel ("L" fin)
- Headers—minimum Sch 40 carbon steel pipe
- Connections—minimum Sch 80 carbon steel pipe
- Casings—minimum 14 ga galvanized steel
- Tubes, headers and connections shall be welded together to form monometallic joints.

Stainless Steel Tube/ Aluminum Fins

- Tubes—minimum 14 ga 304L stainless steel
- Fins—minimum 0.020" thick aluminum (imbedded type)
- Headers—minimum Sch 10 304L stainless steel pipe
- Connections—minimum Sch 40 304L stainless steel pipe
- Casings—minimum 14 ga galvanized steel
- Tubes, headers and connections shall be welded together to form monometallic joints.

NOTE: 0.030" thick aluminum keyfin is an available option for imbedded type only.

Typical Coil Applications

Armstrong can manufacture coils in any configuration necessary to meet your requirements.

- Pulp dryer coils
- Pocket ventilation coils
- Yankee hood drying coils
- Air makeup coils for comfort heating
- Boiler air preheater coils
- Boiler feedwater runaround systems
- Dry kiln coils
- Veneer dryer coils
- Smokehouse coils
- Pasteurizer coils
- Char coolers
- Carpet dryer coils
- Grain dryer coils
- Starch dryer coils
- Textile dryer coils
- Paint spray booth coils
- Drying ovens
- Steam condenser coils
- Unit heaters for comfort heating
- Door heaters
- Tank heating coils
- Unit coolers and condensers

Properties of Saturated Steam

Table 18-1. Properties of Saturated Steam

Gauge Pressure (psig)	Temp. °F	Heat in Btu/lb			Specific Volume cu ft / lb
		Sensible	Latent	Total	
0	212	180	970	1150	26.8
1	215	183	968	1151	25.2
2	219	187	966	1153	23.5
3	222	190	964	1154	22.3
4	224	192	962	1154	21.4
5	227	195	960	1155	20.1
6	230	198	959	1157	19.4
7	232	200	957	1157	18.7
8	233	201	956	1157	18.4
9	237	205	954	1159	17.1
10	239	207	953	1160	16.5
12	244	212	949	1161	15.3
14	248	216	947	1163	14.3
16	252	220	944	1164	13.4
18	256	224	941	1165	12.6
20	259	227	939	1166	11.9
22	262	230	937	1167	11.3
24	265	233	934	1167	10.8
26	268	236	933	1169	10.3
28	271	239	930	1169	9.85
30	274	243	929	1172	9.46
32	277	246	927	1173	9.10
34	279	248	925	1173	8.75
36	282	251	923	1174	8.42
38	284	253	922	1175	8.08
40	286	256	920	1176	7.82
42	289	258	918	1176	7.57
44	291	260	917	1177	7.31
46	293	262	915	1177	7.14
48	295	264	914	1178	6.94
50	298	267	912	1179	6.68
55	300	271	909	1180	6.27
60	307	277	906	1183	5.84
65	312	282	901	1183	5.49
70	316	286	898	1184	5.18
75	320	290	895	1185	4.91
80	324	294	891	1185	4.67
85	328	298	889	1187	4.44
90	331	302	886	1188	4.24
95	335	305	883	1188	4.05
100	338	309	880	1189	3.89
105	341	312	878	1190	3.74
110	344	316	875	1191	3.59
115	347	319	873	1192	3.46
120	350	322	871	1193	3.34
125	353	325	868	1193	3.23
130	356	328	866	1194	3.12
140	361	333	861	1194	2.92
145	363	336	859	1195	2.84
150	366	339	857	1196	2.74
155	368	341	855	1196	2.68
160	371	344	853	1197	2.60
165	373	346	851	1197	2.54
170	375	348	849	1197	2.47
175	377	351	847	1198	2.41
180	380	353	845	1198	2.34
185	382	355	843	1198	2.29
190	384	358	841	1199	2.24
195	386	360	839	1199	2.19
200	388	362	837	1199	2.14
205	390	364	836	1200	2.09
210	392	366	834	1200	2.05
215	394	368	832	1200	2.00
220	396	370	830	1200	1.96
225	397	372	828	1200	1.92
230	399	374	827	1201	1.89
235	401	376	825	1201	1.85
240	403	378	823	1201	1.81
245	404	380	822	1202	1.78
250	406	382	820	1202	1.75
255	408	383	819	1202	1.72
260	409	385	817	1202	1.69
265	411	387	815	1202	1.66
270	413	389	814	1203	1.63
275	414	391	812	1203	1.60
280	416	392	811	1203	1.57
285	417	394	809	1203	1.55
290	418	395	808	1203	1.53
295	420	397	806	1203	1.49
300	421	398	805	1203	1.47
305	423	400	803	1203	1.45
310	425	402	802	1204	1.43
315	426	404	800	1204	1.41
320	427	405	799	1204	1.38
325	429	407	797	1204	1.36
330	430	408	796	1204	1.34
335	432	410	794	1204	1.33
340	433	411	793	1204	1.31
345	434	413	791	1204	1.29
350	435	414	790	1204	1.28
355	437	416	789	1205	1.26
360	438	417	788	1205	1.24
365	440	419	786	1205	1.22
370	441	420	785	1205	1.20
375	442	421	784	1205	1.19
380	443	422	783	1205	1.18
385	445	424	781	1205	1.16
390	446	425	780	1205	1.14
395	447	427	778	1205	1.13
400	448	428	777	1205	1.12
450	460	439	766	1205	1.00
500	470	453	751	1204	0.89
550	479	464	740	1204	0.82
600	489	475	728	1203	0.74

Basic Formulas—Steam Coils

Formula Numbers

24-1 "F" Factor = $$\frac{\text{Saturated Steam Temperature - Entering Air Temperature}}{\text{Saturated Steam Temperature - Leaving Air Temperature}}$$ = Surface Performance

24-2 Air Flow Rate (SCFM) = ACFM x Temp. Correction Factor (Table 24-1) x Altitude Correction Factor (Table 24-2)

24-3 Air Flow Rate (SCFM) = $$\frac{\text{lbs/hr Air}}{4.5}$$

Where: 4.5 = Density Of Air At 70°F, Sea Level (0.075lbs/ft³) x 60 Minutes Per Hour

24-4 Face Area (sq ft) = $$\frac{\text{Air Flow Rate (SCFM)}}{\text{Air Velocity}}$$

24-5 Air Velocity (FPM) = $$\frac{\text{SCFM}}{\text{Face Area sq ft}}$$

24-6 Actual Airside Pressure Drop (in wg) = $$\frac{\text{One Row Air Pressure Drop x (.2 + .8 x R)}}{\text{Tf x Af}}$$

Where:
- R = Number of rows of finned tube in direction of air flow
- Tf = Average air temperature correction factor (Table 24-1)
- Af = Altitude correction factor (Table 24-2)

24-7 Heat Load (Btu/hr) = Air Flow Rate (SCFM) x 1.08 x Air Temp. Rise (°F)

Where:
1.08 = Density Of Air At 70°F, Sea Level (0.075 lb/ft³) x 60 Minutes Per Hour x Specific Heat Of Air (0.24 Btu/lb/°F)

24-8 Steam Consumption (lb/hr)= $$\frac{\text{Heat Load (Btu/hr)}}{\text{Latent Heat of Steam}}$$ or $$\frac{\text{Air Flow Rate (SCFM) x 1.08 x Air Temp. Rise (°F)}}{\text{Latent Heat of Steam}}$$

Table 16-1. Temperature Correction Factors

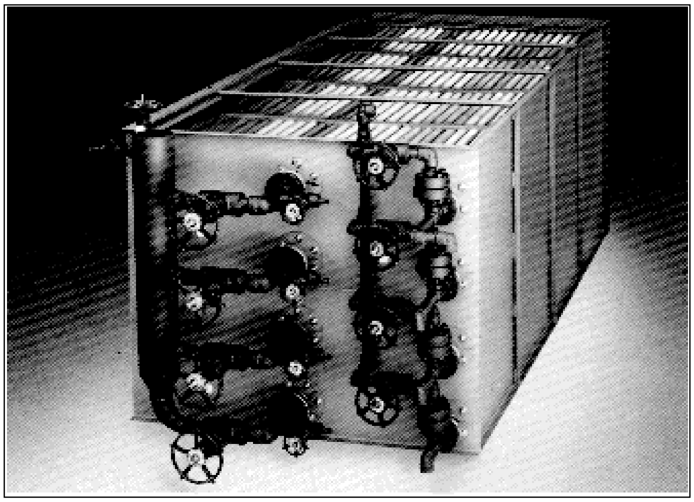
Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor	Temp.°F	Factor
-45	1.277	5	1.140	55	1.029	105	0.938	155	0.862	205	0.797	255	0.741	305	0.693
-40	1.262	10	1.128	60	1.019	110	0.930	160	0.855	210	0.791	260	0.736	310	0.688
-35	1.247	15	1.116	65	1.010	115	0.922	165	0.848	215	0.785	265	0.731	315	0.684
-30	1.233	20	1.104	70	1.000	120	0.914	170	0.841	220	0.779	270	0.726	320	0.679
-25	1.218	25	1.093	75	0.991	125	0.906	175	0.835	225	0.774	275	0.721	325	0.675
-20	1.205	30	1.082	80	0.981	130	0.898	180	0.828	230	0.768	280	0.716	330	0.671
-15	1.191	35	1.071	85	0.972	135	0.891	185	0.822	235	0.763	285	0.711	335	0.667
-10	1.178	40	1.060	90	0.964	140	0.883	190	0.815	240	0.757	290	0.707	340	0.663
-5	1.165	45	1.050	95	0.955	145	0.876	195	0.809	245	0.752	295	0.702	345	0.658
0	1.152	50	1.039	100	0.946	150	0.869	200	0.803	250	0.746	300	0.697	350	0.654

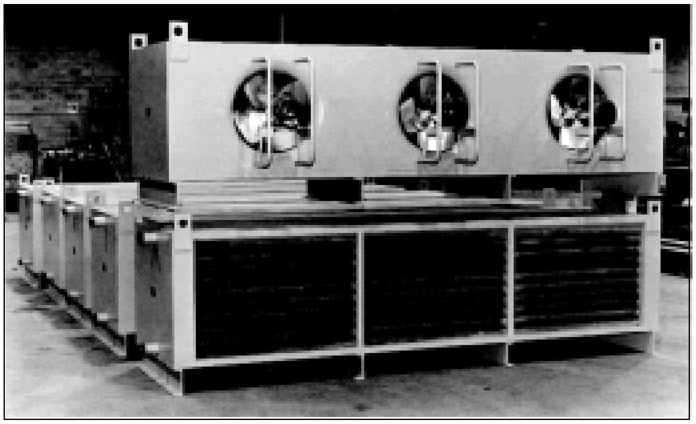
Table 16-2. Altitude Correction Factors

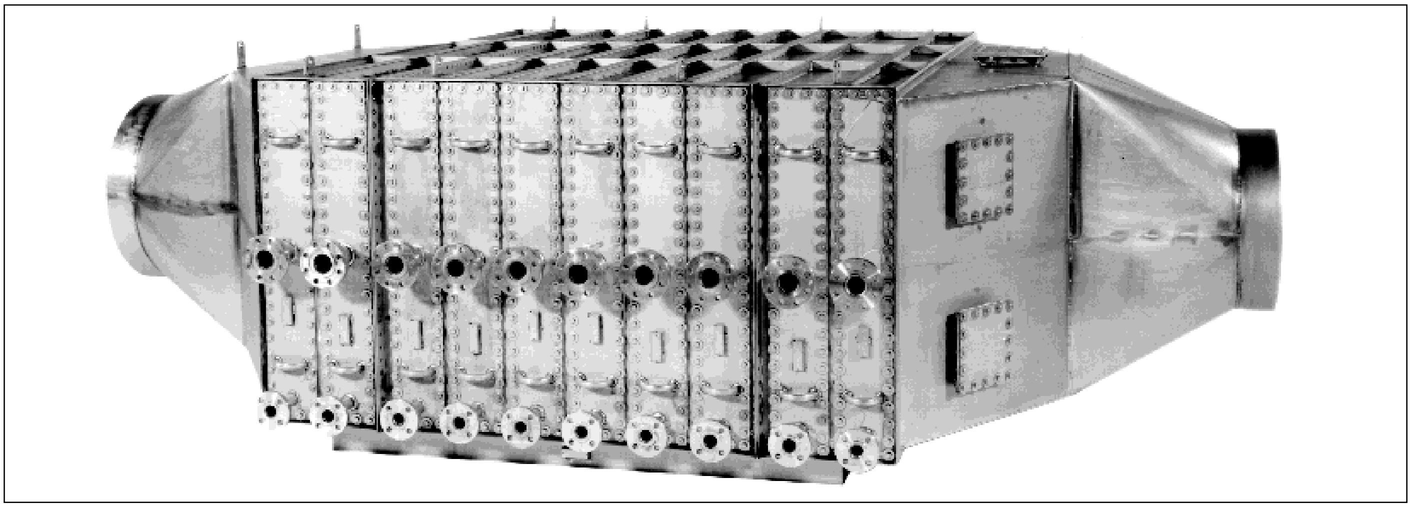
Altitude (Ft Above Sea Level)	Factor	Altitude (Ft Above Sea Level)	Factor	Altitude (Ft Above Sea Level)	Factor	Altitude (Ft Above Sea Level)	Factor	Altitude (Ft Above Sea Level)	Factor	Altitude (Ft Above Sea Level)	Factor
0	1.000	1750	0.937	3500	0.877	5250	0.822	7000	0.769	8750	0.719
250	0.991	2000	0.928	3750	0.869	5500	0.814	7250	0.762	9000	0.712
500	0.981	2250	0.920	4000	0.861	5750	0.806	7500	0.754	9250	0.705
750	0.972	2500	0.911	4250	0.853	6000	0.798	7750	0.747	9500	0.698
1000	0.963	2750	0.903	4500	0.845	6250	0.791	8000	0.740	9750	0.691
1250	0.954	3000	0.894	4750	0.837	6500	0.783	8250	0.733	10000	0.684
1500	0.945	3250	0.886	5000	0.829	6750	0.776	8500	0.726	10250	0.677

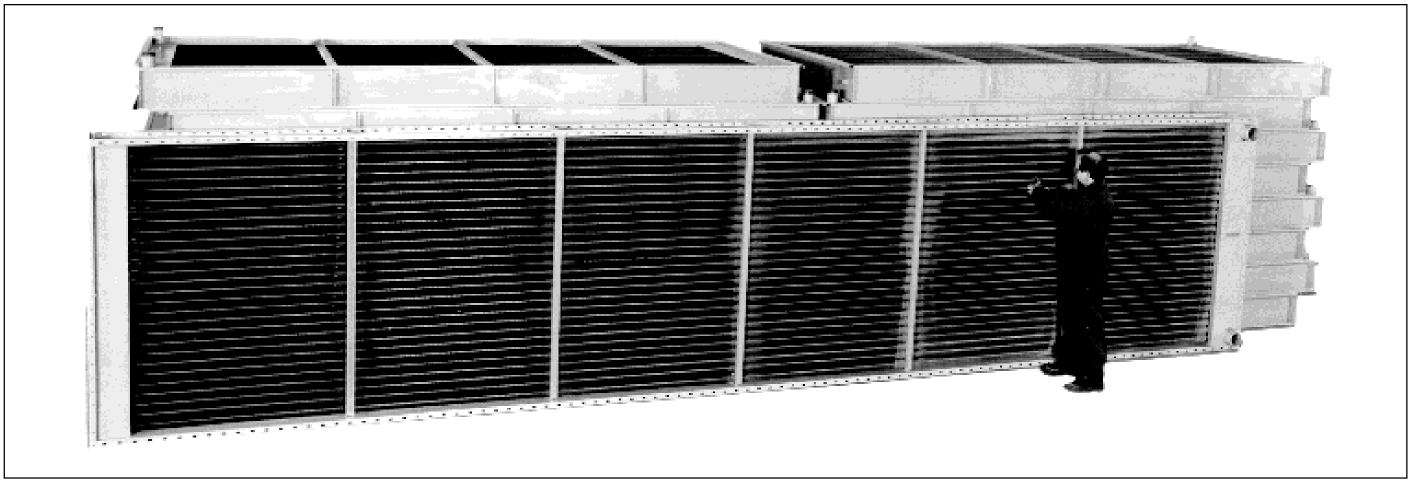
For air volume given at temperatures other than 70°F or altitude other than sea level, **multiply** volume by above factors to obtain air volume at standard conditions.
Performance and air pressure drops are based on standard conditions of 70°F and 29.92 inches mercury.
For air pressure drop, **divide** by altitude factor and factor for **average** air temperature.

Coil Packages Engineered to Your Specifications


Air heaters using high pressure steam.


Blast air coolers and heaters.

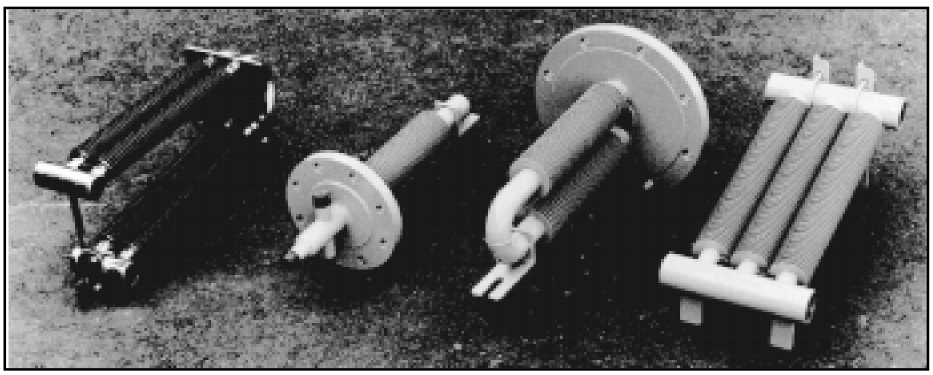

Stainless steel boiler air pre-heaters used in the pulp and paper industry.


Air heaters using thermal oils.

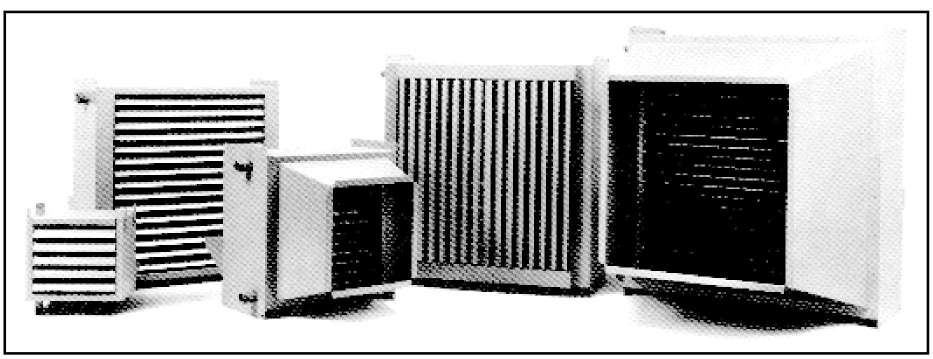
Limited Warranty and Remedy

Armstrong-Hunt, Inc. warrants to the original user that those products supplied by it and used in the service and in the manner for which they are intended shall be free from defects in materials and workmanship for a period of one (1) year after installation, but not longer than fifteen (15) months from date of shipment. This warranty does not apply to core failures due to external or internal corrosion caused by improper selection of materials, drainage devices or installation by the customer. CAUTION: Subcooling drainage devices are improper for use on Armstrong-Hunt steam coils. Contact your Armstrong-Hunt, Inc. Representative for further details. Except as may be expressly provided for in a written agreement between Armstrong-Hunt, Inc. and the user, signed by both parties, Armstrong-Hunt, Inc. DOES NOT MAKE ANY OTHER REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. The sole and exclusive remedy with respect to the above limited warranty or with respect to any other claim relating to the products or to defects or any condition or use of the products supplied by Armstrong-Hunt, Inc. however caused, and whether such claim is based upon warranty, contract, negligence, strict liability or any other theory, is limited to Armstrong-Hunt, Inc.'s repair or replacement of the part or product, excluding any labor or any other cost to remove or install said part or product or, at Armstrong-Hunt, Inc.'s option, to repayment of the purchase price. Notice of any such claim must be given in writing to Armstrong-Hunt, Inc. within fifteen months after the first installation or use of the products. In no event shall Armstrong-Hunt, Inc. be liable for special, direct, indirect, incidental or consequential damages, including, but not limited to, loss of use or profits or to interruption of business activity.

Other Products



Tank heaters.



Unit heaters and door heaters.

Tank Heaters
Critical to heating and temperature maintenance for a broad variety of products, Armstrong-Hunt tank heaters are widely used in breweries, chemical and food processing plants, oil refineries, paper mills, tank storage farms and in shipping and other industries.

Unit Heaters
Heavy-duty Armstrong-Hunt unit heaters combine superior design and top-quality materials/construction for a longer-lasting unit less subject to failure due to corrosion, erosion or leaks.

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Catalog AH-112-E 12M 8/98 www.armstrong-intl.com Printed in U.S.A.