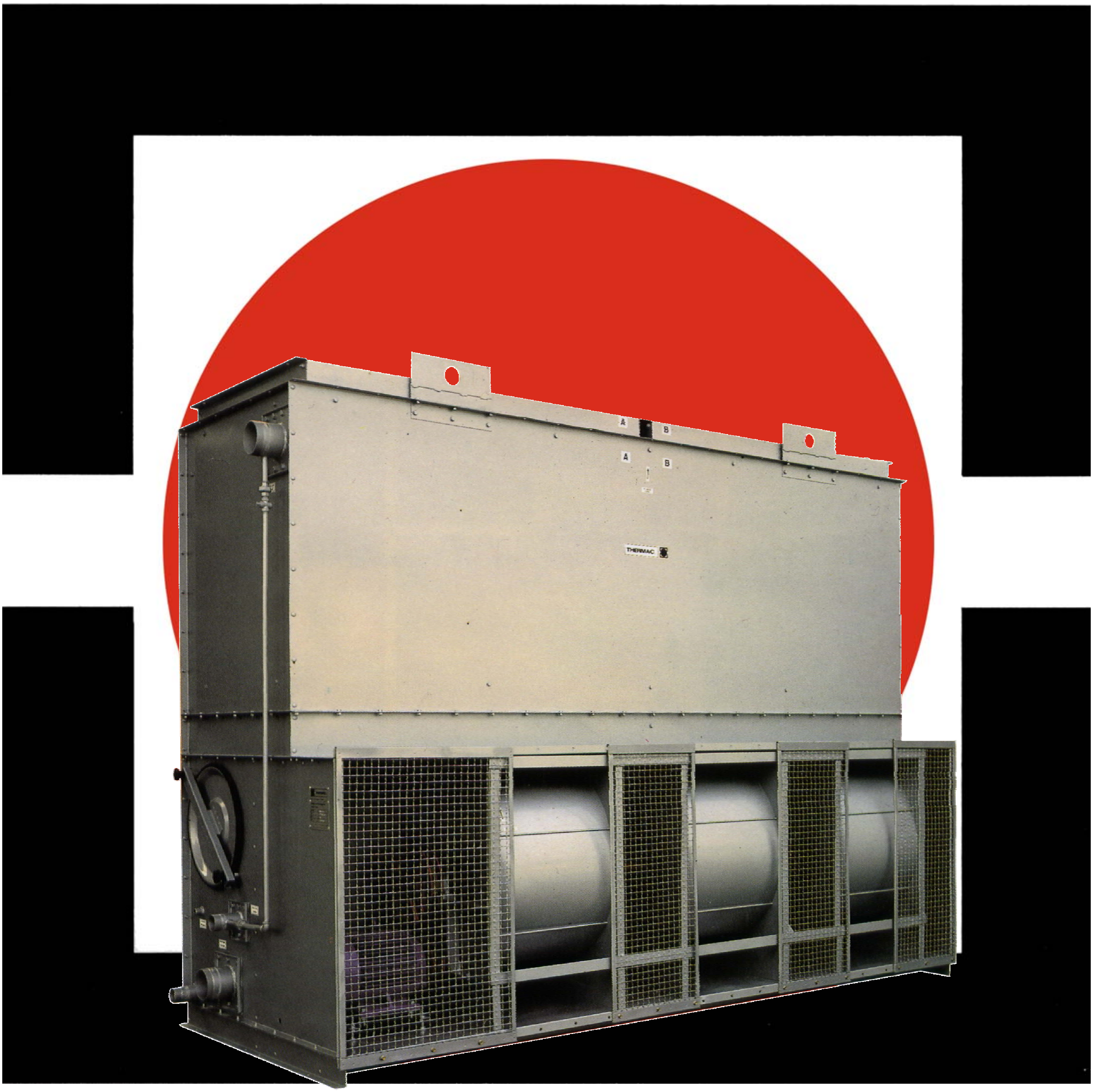
THERMAC®



COOLING TOWER

INDEX

COOLING TOWERS series TE, TCN, DTCN, TA, LCT
for civil and industrial applications

The range of cooling towers for civil and industrial applications produced by THERMAC is one of the most complete existing in the international market. The range is based on five different series of products for a total of 49 sizes, covering capacities from 22 kW to 4360 kW (18750 to 3750000kcal/h). bigger capacities can be obtained by a modular combination of several base units, which is a standard procedure for industrial application.

The high number of available sizes allows, in every case, a precise unit selection, at the right cost, without compromises for over or under sizing.
The construction of all THERMAC cooling tower models is at the highest quality level of this industry and features special devices (described in the following pages) which reduce lifting and transport problems and installation costs.

The resistance to atmospheric agents, which create rust and corrosion, particularly in industrial or marine ambient, is another strong point in favour of selecting a THERMAC cooling tower. The heat exchange efficiency of all models, which reaches particularly high values, contributes to a sensible limitation of energy and water consumption.

Several design alternatives and optional accessories are available to match specific installation and operation reqirements for civil and industrial applications.

THERMAC Engineering Dept. has acquired a vast experience in the design of heat exchange equipment with a remarkable field-obtained know-how caused by the follow-up of installations in the most diversified operational conditions.
Thanks to this experience, THERMAC can face any fluid cooling technological problem, even if largely outside standard conditions, according to Client, Designer or Installer requirements, with the confidence of finding the right solution in terms of functionality, reliability, efficiency, operation.

All THERMAC cooling towers are designed by means of aCAD system, which guarantees an accurate unit dimensioning perfectly matching the operating conditions at a minimum cost.

WIDE MODEL SELECTION

THERMAC cooling towers are divided in five models each of which gives a solution to different application requirements. The main characteristics of each series are hereinafter summarized.

Series 4 TE

These are small capacity, available in 4 sizes, from 22 to 65 kW (18750 – 56000 kcal/h), suitable for use with package units or small water chillers. They feature an axial fan, very simple yet sturdy construction, great operational reliability and an interesting cost. The low noise level and the reduced water consumption make it possible to install these units even in urban areas with high population density.

Series 12 TCN

These towers features centrifugal fans mounted on one side only in a semi-enclosed position, protected from rain, snow or hail. They cover an intermediate capacity range from 87 to 436 kW (75000 to 375000 kcal/h) which is most frequently used for standard civil and commercial airconditioning installations. The units are available in 12 sizes, with capacity increments about 10% between two consecutives sizes, to allow an exact selection at the lowest cost.
The series 12 TCN cooling tower can be ducted on the suction inlet and discharge outlet for internal installation; they can be equipped with sound attenuators (see the followiong pages) to reduce the sound level.
The position of the fans on one side only allows placement against a wall.
These units are designed for assembly on antivibration mounts without the necessity of supporting beams, as it is common to most of the other cooling towers in the market, thanks to the reinforced base structure. This greatly reduces installation costs.
The cooling tower can be normally lifted from lugs in the upper part without yielding of the bottom.

Series 10 DTCN

This cooling tower series is the continuation of the previous 12 TCN series. The units have a double centrifugal fan section, placed on opposed sides in a semi-enclosed position. The range of capacities is from 520 to 1750 kW (450000 to 1500000 kcal/h) divided over 10 different sizes. They can be used in relatively large civil installation, in refrigeration plants and, generallt, in process fluid cooling. It is possible to duct the air inlet and outlet to install sound attenuators on the suction or discharge side to reduce the noise level. Also these cooling towers can be positioned on antivibration mounts, tithout the necessity of supporting beams thanks to the reinforced base structure. For this reason it is also possible to lift the cooling tower from lugs in the upper part without yielding of the bottom. The units can be decomposed in a modular way to facilitate freight and site positioning.

Series LCT

These are modular units of large capacity for civil or industrial application. They feature internally placed centrifugal fans, not protruding from the tower cabinet. The capacity range of the standard units covers from 890 to 2500 kW (765000 to 2150000kcal/h) divided over 8 sizes. However, assembling together several base modules it is possible to reach much higher capacities up to more than 7400 kW (6380000 kcal/h).

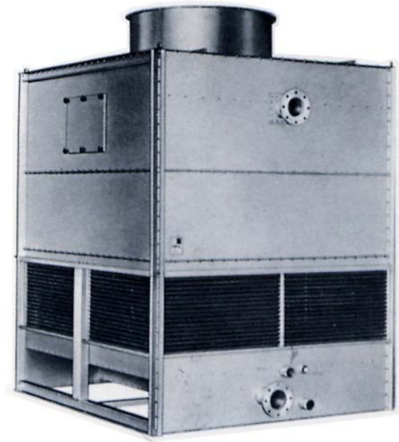
The unit construction is particularly sturdy and "heavy duty".

The cooling tower can be positioned on antivibration mounts without the necessity of supporting beams, thanks to the reinforced base structure. For this same reason it is also possible to lift the cooling tower from lugs in the upper part.

Series 15 TA

The cooling towers of this series are particularly suitable for large industrial applications where energy consumption limitation is quiet important. The 15 TA towers features aerofoil axial fans directly coupled to totally enclosed motor, suitable for operation in high humidity ambient. The modular construction of these units makes it possible to assemble together several base modules to form a high capacity heat rejection system. The standard construction is based on 15 sizes with capacity from 520 to 4360 kW (450000-3750000kcal/h). the 15 TA towers have a particularly sturdy construction to face the heavy duty working conditions.

A characteristic feature of these towers is that the sheet metal sump tank can be eliminated when an existing tank can be used. In this case the air enters the cooling tower through particularly shaped louvers which do not allow water discharge.



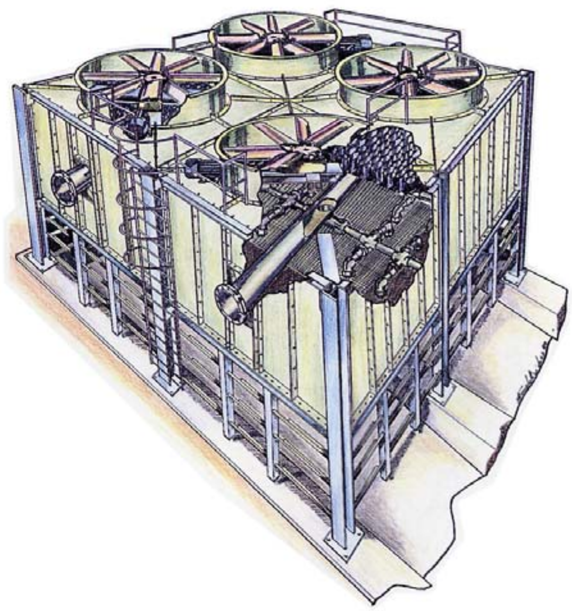
Series TAG

The THERMAC range also includes industrial cooling tower of very large size of the TAG series, featuring axial fans connected to the electric motor by means of a gear reducer.

The capacity can reach up to 5MW for each cell with a 4mt diameter fan.

The towers can be with or without sump tank. The structure is in steel profiles hot dip galvanized after fabrication with painted or galvanized panels.

These towers are custom designed to follow the particular customer requrement.



THE THERMAC QUALITY
Advantages for contractors, designers, end users

The THERMAC production is at the highest industry standard. It is a choice to which considerable human an financial effort has been dedicated in order to obtain a product capable of obtaining without compromises the preferences of contractors, designer and end users. The main constructional, installation and operation features, common to all cooling towers models are hereafter described.

Great sturdiness and resistence to atmospheric agents

The standard construction is in Sendzimir galvanized steel. The thickness is variable in accordance with the cooling tower size in order to ensure in any condition the maximum constructional strength and structural rigidity. The panels are assembled by means of zinc-chromatized bolts, with the interposition of high elasticity mastics to guarantee a good sealing even after years of operation.

The bigger sizes are manufactured in separate sections for ease of transport and site positioning.

Large size panels or manholes, according to model sizes, allow an internal inspections or services.

All cooling tower models, upon request, can be manufactured in special materials:

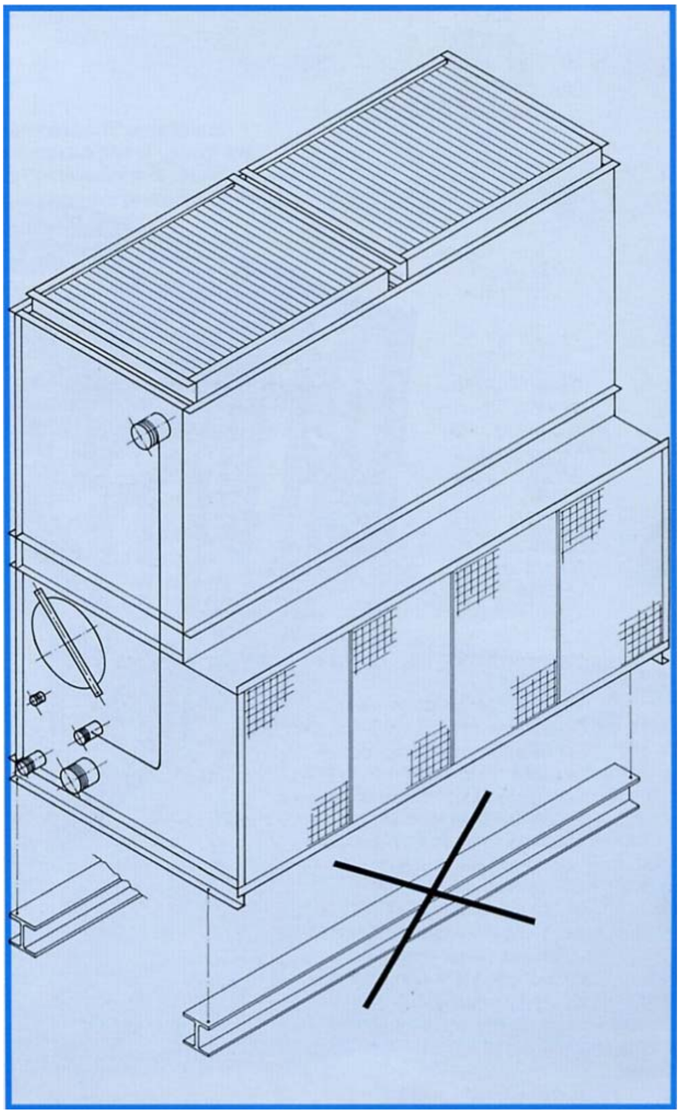
AISI 304, AISI 316 and peralluman.

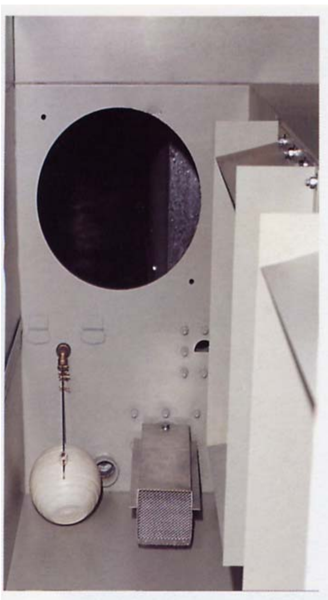
Also the wet deck are available in different materials for particular operating conditions (see Optionals and Accessories)

No necessity of supporting beams for installation on antivibration mounts

The THERMAC cooling tower base is strengthened by a series of profiles specifically suitable for installation on antivibration mount, without any necessity of supporting beams, as is requested for most of the cooling towers available in the market.

This particular feature reduces the installation times and costs, and makes it possible to lift the cooling tower from lugs in the upper part without any danger of yielding or deformation of the bottom part.





Maximum protection against athmospheric agents and industrial fumes

All the Sendzimir galvanized steel panels that make up the cooling tower casing undergo individually an extended THERM-O-PAINT painting cycle with oven baking. After assembling a further painting cycle eliminates the possibilities of paint scratches due to assembly.

The fan impellers undergo the same painting cycle of all other components.

All these features guarantee an over 10 years unalterability of the cooling towers in high pollution urban areas, while also giving a high resistance in marine athmosphere or in areas with industrial fumes. This can be translated in short servicing times and low maintenance costs for the end-user and in extended operational life.

Therm – o – Paint
THERMAC specification for the painting of the cooling towers

Primer

colour:	green
bonding agento	Epoxypolyamidic
aspect of dry film:	semi-matte
roduct type:	bicomponent
catalyst:	
catalysis ratio:	100 p. paint / 25 p. catalyst

Finish

colour:	aluminium
bonding agent:	acrylic
aspect of dry film:	bright
product type:	bicomponent
catalyst:	
catalysis ratio:	100 p. paint / 50 p. catalyst

Painting cycle
* cold zinc on weldings and edges:
* cleaning and degreasing with solvent;
* application of prime coat with catalist @ 25%;
* drying time: 6 hours minimum;
* application of intermediate coat with catalyst @ 50%;
* application of finish coat with catalyst @ 50%;
* drying time: 48 hours minimum.

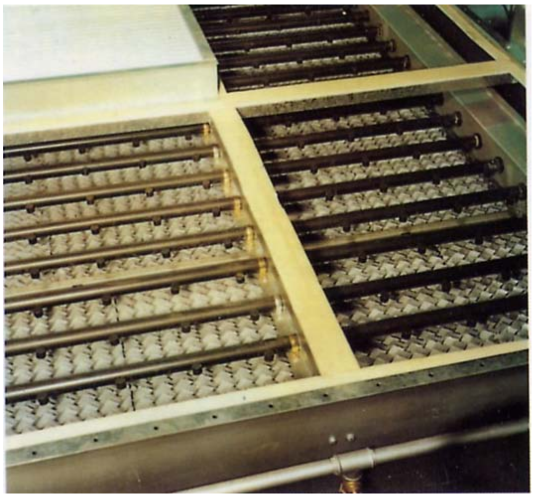
This specification refers to all the towers subjected to painting (motors and drives excluded). The finish is applied on the external walls only.

Wide surface wet deck
The wet deck is formed by a cellular PVC structure with wide contact surface to enable an efficient and uniform distribution of the water droplets sprayed by the nozzles. The water ways in the wet deck are downward inclined in such a way to maximize the heat exchange surface between air and water.
The inclination angle also opposes water carry over outside the wet deck.
The above feature optimize the heat exchange efficiency and contributes greatly to limit the water consumption.
The standard wet deck is in rigid PVC, stabilized to UV radiation, with a maximum operation temperature of 80°C.
Upon request the wet deck can be supplied in one of the following materials:

- Self extinguish black PVC, class M1
- High temperature PVC, up to 120°C
- Galvanized steel
- Stainless steel

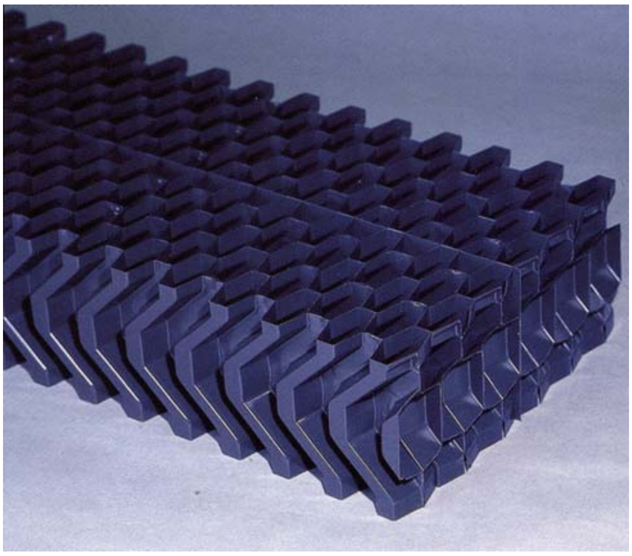
It is therefore possible also the cooling of water or process liquids at high temperature.

Sump tank: strength and rigidity and corrosion resistance
The sump tank is assembled with sheet metal panels externally painted with the same method alredy described and zinc-chromatized bolts. After assembly a special bituminous paint is sprayed over the internal surface to give a maximum protection against the corrosion caused the increasing amount of aggressive parts in the water.
On the sump tank are mounted the make-up water connections with automatic float valve, the over-flow connection and the drain connection. On the water outlet to the installation circuit a metallic filter retains dirt particles or heavier solids.
On the water inlet pipe, a by-pass tube with bleed-off valve allows a continuous water dilution to keep under control the water salt concentration.



Low pressure drop water sray nozzles
The nozzles have been recently redesigned with large diameter and great water flow allow an extended and uniform water distribution. They are made of rubber for an actual self-cleaning action when solid parts pass through them.
The large nozzles diameter reduces the pump head and consequently the energy consumption. The nozzles are mounted over polyvinil or polypropilene spray pipes with a quick release fastening system for ease of inspection or replacement.
The nozzles distribution pipes are fixed by means of O-RINGS on a steel header and are therefore easily removable.

Droplet eliminators
Our towers are equipped with specially designed droplet eliminators for vertical air-flow; their four direction changes assure an efficiency up to 99%.
Droplet eliminators are made of high quality PVC, with special pigment which gives high resistance to environment agents, to UV ray and to inorganic chemical agents.
The droplet eliminators are solidly fastened to the tower structure, so they can't be diverted from their lodging by bad weather.
Moreover, they are strong enough to weather the hail storm.
The fastening system allows an easy disassembling and or substitution.



Optional e Accessories
All THERMAC cooling towers can be equipped with several optional and accessories to meet specific installation requirements.
The main accessories and optional are as follows:

- Special material construction: AISI 304; AISI 316; Peralluman.
- Wet deck in special material: self-extinguishing black PVC; high temperature (120°C) PVC; galvanized steel, stainless steel.
- Double speed fan motors (4/6 or 4/8 poles) to control tower capacity.
- Centrifugal fan outlet damper actuated by outside temperature to control tower capacity.
- Antifreeze sump tank electric heaters with or without thermostat.
- Noise attenuation cowls for installation on air inlet or outlet. Within certain limits the tower noise can be attenuated by these cowls at the lower cost than attenuators (see next item).
- Sound attenuators for installation on air inlet or outlet available in length of mm 500, 1000 or 1500 (see description in the next pages).
- Bigger fan motors (available only on 12 TCN an 10 DTCN) to achieve fan static pressure up to 80 Pa (8 mm w.g.) for ducting or sound attenuators installation.
- "Antifume" coils to prevent fog formation (see description in the next pages).

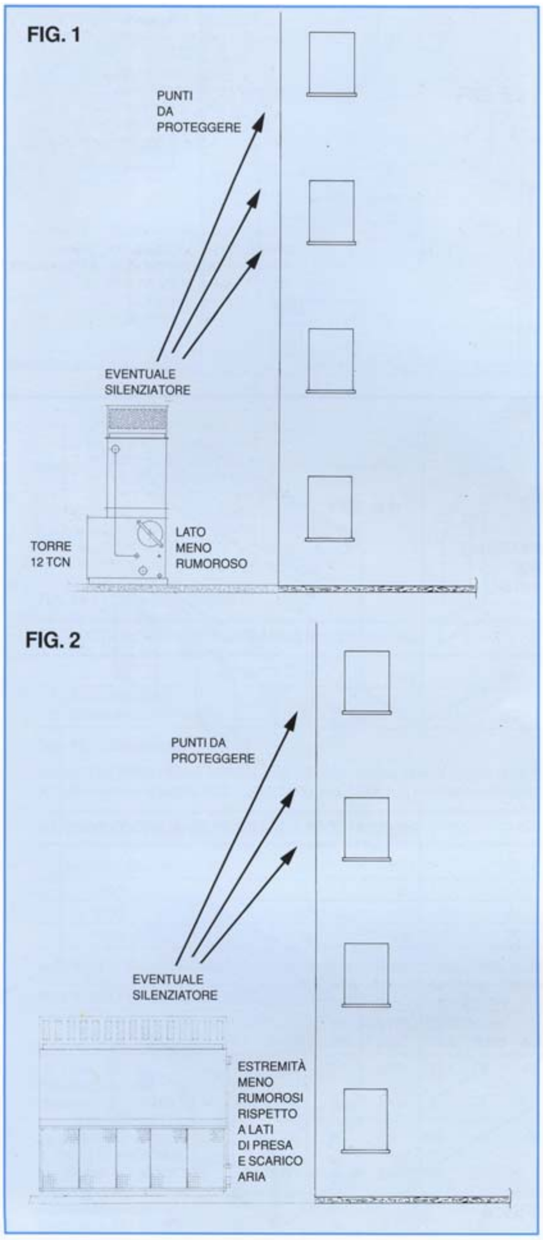
Efficient fans with low noise level
Mod. 12TCN, 10DTCN, LCT.
The fans mounted on these cooling tower series are of the DWDI centrifugal type, forward curved, selected for a tolerably low noise level. The fan drive is by means of pulley and trapezoidal section belts. The motor is of the TEFC type suitable for high moisture ambient, and it is mounted on an adjustable skid placed inside the fan section, for a better protection against rain and snow.
The motor shaft is cadmium plated is supported by balls bearings. Both motor and fan bearings are of the permanently oiled type. On all these models the fan section is protected by a galvanized and painted steel mesh to prevent accidents and collision with solid objects.

Mod. 4TE, 15TA.
These towers are equipped with aerofoil axial fan in light alloy, directly coupled to the electric motor. The motor is watertight suitable for operating in saturated air.
The shaft is cadmium plated steel and is supported by permanently oiled ball bearings.

The fans undergo the same painting cycle already described for other components. The fans are statically and dynamically balanced.

COWLS AND ATTENUATORS FOR NOISE CONTROL

FIG. 1



The series 12 TCN and 10 DTCN cooling towers can be equipped with two different systems for noise control:

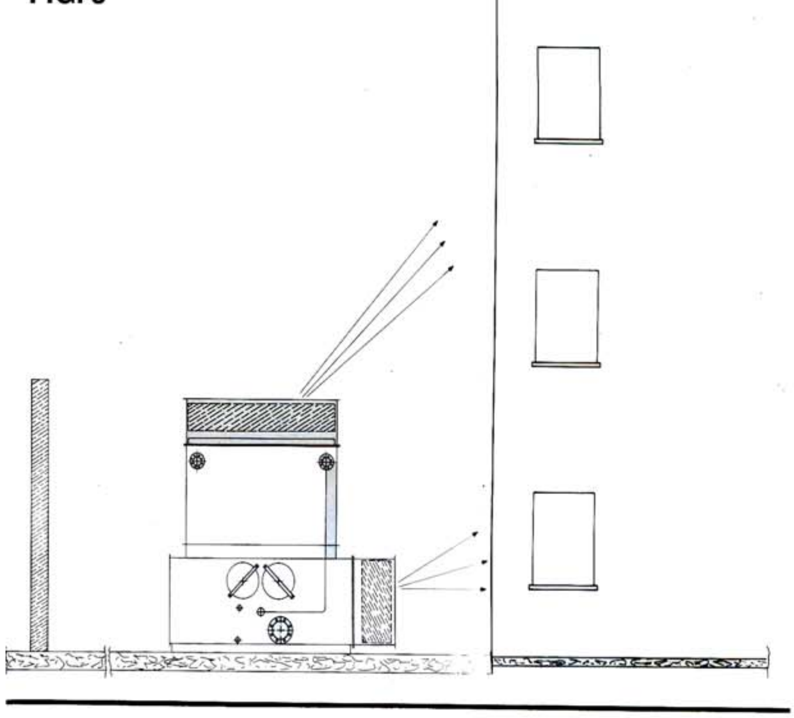
* attenuation and deviation cowls with acoustic barrier effect. They can be installed on the air inlet or outlet in order to the noise direct propagation towards neighbouring zones. These cowls are manufactured in Sendzimir galvanized steel sheet with internal glass-fibre sound absorbing mat, protected by a perforated metal sheet.
The complete cowl is painted with the same system described for other components. The inlet or outlet air is deviated by the cowls and also the noise is deviated and partially attenuated and does not hit directly the protected areas.
The cowl sound attenuation is definitely inferior to that achieved by proper sound attenuators but also their cost is sensibly lower. In many cases the cowls are sufficient and can be conveniently used.
Attenuation values are reported in Table 1°.

* sound attenuators of different length: 500, 1000, 1500 mm, with different noise attenuation capacity. See Tab. 1b. The attenuators can be mounted in various positions: on the air inlet, on the air outlet or on both according to the noise reduction requirements and to the site characteristics.

Generally speaking the fan section side produces a higher noise level than any other side, included the upper air outlet. The lower noise side is that closed and opposite to the fan section (mod 12 TCN): the difference can be 6-8 dB for low frequencies and even more the 12 dB for higher frequencies.
Therefore when designing an installation a proper tower orientation can reduce sensibly the noise emission towards the protected areas.

After the fan section the noise part is the upper section. Therefore if the cooling tower is installed at ground level and near a multistore building it may become necessary to protect the upper floors the outlet air noise by installing a cowl or a sound attenuator on the air outlet. If the tower is a 12 TCN model with a single fan section, the lower floors can be protected by orientating the fan section side in the opposite direction. See fig. 1. If the tower is a 10 DTCN model it should be positioned with the short side towards the building. See fig. 2.

FIG. 3



Were this is not possible it may become necessary to install the cowls or the attenuators also on the air inlet side. See fig. 3.
The TERMAC cooling tower sound pressure level are shown in the relative table.
As it is known the level has an attenuation as a function of the distance following the equation:

$$\Delta L p = 20 \log L/L_{rif} \text{ , dB}$$

where: L = actual distance from the tower
L_{rif} = distance at which the sound pressure measurement has been taken.
For THERMAC cooling towers this distance is 5 mt.

The noise level is however increased if the tower is installed near a reflecting wall. See fig. 4. Practically the overall sound level of a tower installed near a wall is increased by 6 dB; if the tower is installed in a corner between two walls, the overall sound level is increased by 9 dB.
It is always recommended that the cooling tower be installed on a flat surface without nearby walls.

Acoustical selection example
A 12 TCN 60 cooling tower must be installed at a distance of 10 m from the property limit at which the sound pressure level must be NC 40 (see fig. 5a). The tower has a sound level of NC 56, as per table. On the graph it is shown spectrum together with the sound level corresponding to NC 40.

Solution
First of all it should be calculated the sound attenuation due to the distance as per the formula

$$\Delta L p = 20 \log L/L_{rif} = \Delta L p = 20 \log 10/5 = 6 \text{ dB}$$

The sound attenuation is therefore 6dB for all frequencies. This value can be deducted from the 12 TCN sound pressure level.
It is now nwcwssary to check the differences of sound level between the attenuated noise and the required NC 40 condition,
From the table it can be seen that the excess differences are:

Hz 125	:	+ 3 dB
Hz 250	:	+ 1 dB
Hz 500	:	+ 5 dB
Hz 1000	:	+ 9 dB
Hz 2000	:	+ 7 dB
Hz 4000	:	+ 6 dB

Therefore, to respect the NC 40 requirement it will be necessary to select a silencer with an attenuation value at least equal for each frequency to the above values. From table 1 we select a 500 mm silencer, which is largely sufficient. It will have to be mounted on the fan section air inlet.

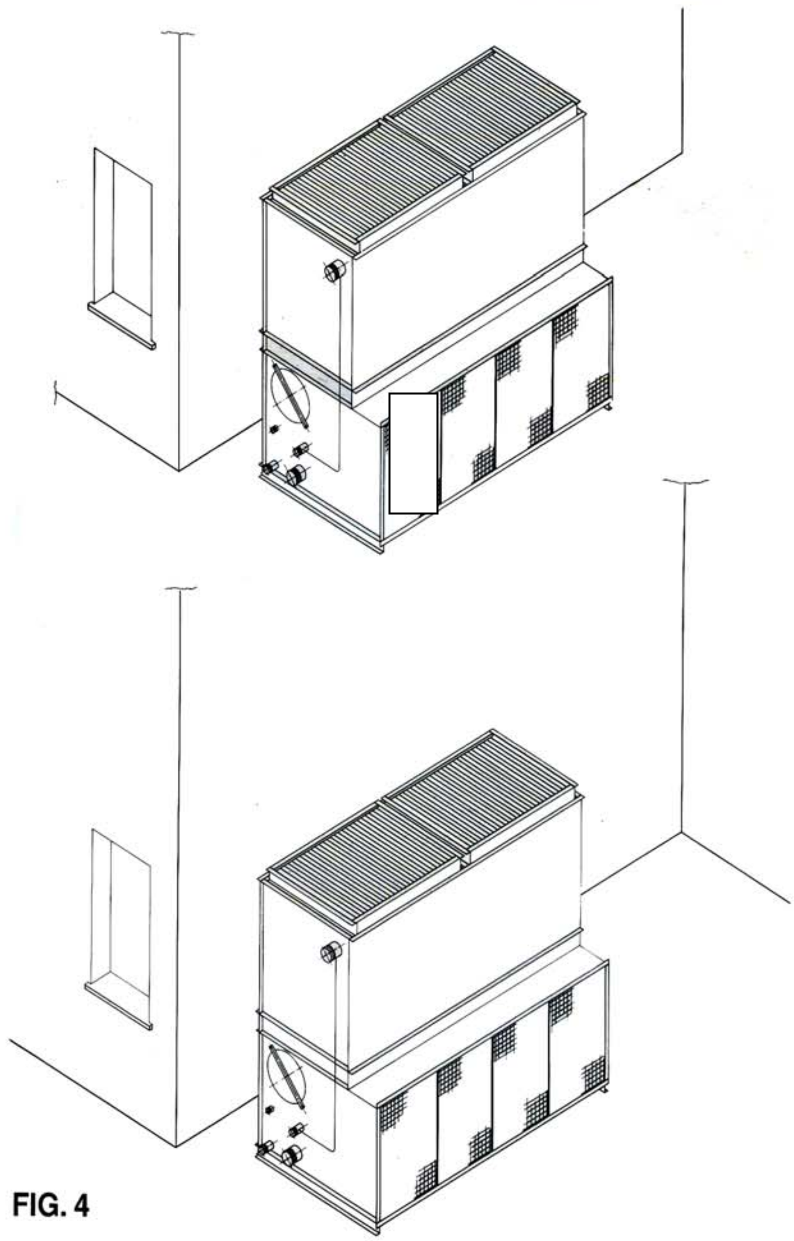


FIG. 4

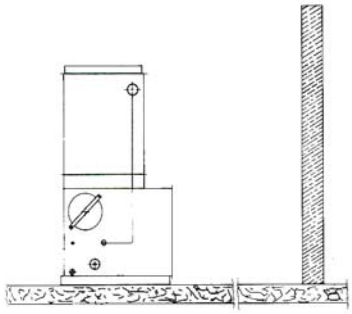


FIG. 5 a

The same procedure is also applicable for the acoustic cowls. In this case the specific cowl attenuation values should be used.

Note: if the protected area had been at a higher level than the tower the same procedure could be applied; the result would have been even more favourable for two reasons: a) a lower sound level at the air outlet; b) a higher attenuation effect due to the distance as the protected area would only be interested by a component of the total acoustic emission due to inclination angle. See fig. 5b.

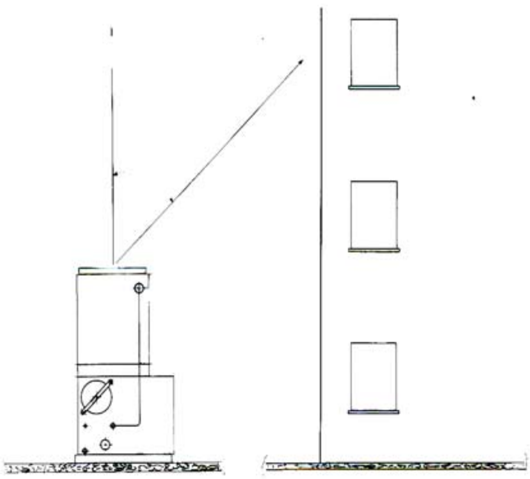
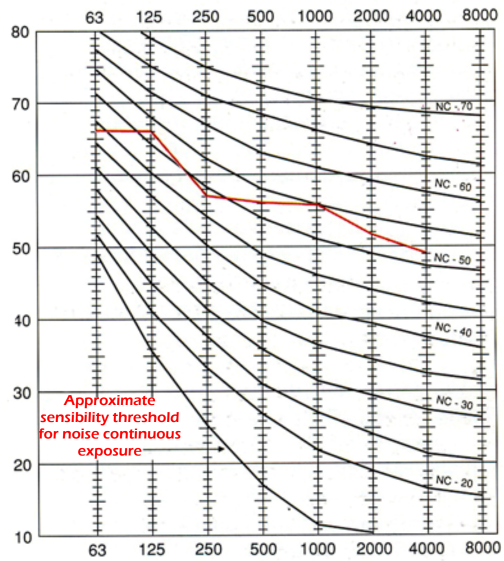


FIG. 5 b

GRAPH NOISE CRITERIA



Tab. 1a – Attenuation Cowls

OCTAVE BAND (Hz) ATTENUATION IN dB							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**
Discharge or suction cowl	**1**	**1**	**6**	**12**	**14**	**16**	**16**

Tab. 1b – Sound attenuators

THERMAC cooling towers series 12 TCN and 10 DTCN can be supplied with sound attenuator section of 3 different lengths 500, 1000, 1500 mm. Attenuation values are as per table.

OCTAVE BAND (Hz) ATTENUATION IN dB							
LENGTH mm	63	125	250	500	1000	2000	4000
500	2	4	8	12	16	18	13
1000	6	10	17	24	35	36	26
1500	7	13	24	35	39	39	36

Note: due to different tower installation situations the values shown in table 1a and 1b must be considered approximate

ACOUSTICAL SELECTION SUMMING-UP

	BAND CENTRE FREQUENCY Hz								Note
Tower Lp (dB)	63	125	250	500	1000	2000	4000	NC 56	As shown on Noise Criteria Graph
Attenuation for a 10m distance	67 -6	66 -6	57 -6	56 -6	56 -6	52 -6	49		
Net Lp (dB) at a distance of 10 m	61	60	51	50	50	46	43	NC 40	As shown on Noise Criteria Graph
Lp corrisp. to NC 40 (dB)	57	50	45	41	39	37			
Necessary attenuation to meet NC 40, dB	3	1	5	9	7	6			

Some practical indications about the correct installation of the water pipes between the cooling tower and the condenser are noted here: they refer, however, to the most common cases.

1. Pump location
   The circulating pump must be positioned below the tower sump tank. It must have a suction head of at least 30 cm, in order to offer a reasonable safety margin against pump cavitation, with air in the circuit and consequent unproper operation of the whole installation, which may cause severe damage on the refrigeration compressor.
   Two examples are given in fig. 6 in which the pump suction heads are quite different although the level difference between tower and condenser is identical. Preference should be given to the solution with higher head.

2. Sump tank to pump suction line dimensioning
   It is advisable to select the sump tank to pump pipe diameter in such a way to minimize the pressure drop. A good rule is to select one size up from the calculated diameter: in fact it must be remembered that the pressure drop on the section of the pipe will increase in the time due to filter clogging and pipe scaling.

3. Hydraulic circuit total pressure drop calculation
   The hydraulic circuit total pressure drop is given by the sum of the following components:
   - pipework pressure drop
   - condenser pressure drop
   - tower nozzles pressure drop
   - pump geodetic head.
   It's a good rule to increase the total so obtained by a good 205 to allow for the pipe section restriction due to scaling, the filter clogging, etc.

4. constance of the pump geodetic head
   the geodetic head is formed by the difference by the pump supply head and the pump suction head. For a given cooling tower size the geodetic head remains constant, indipendently from the type of circuitation, and can be seen in fig. 6.

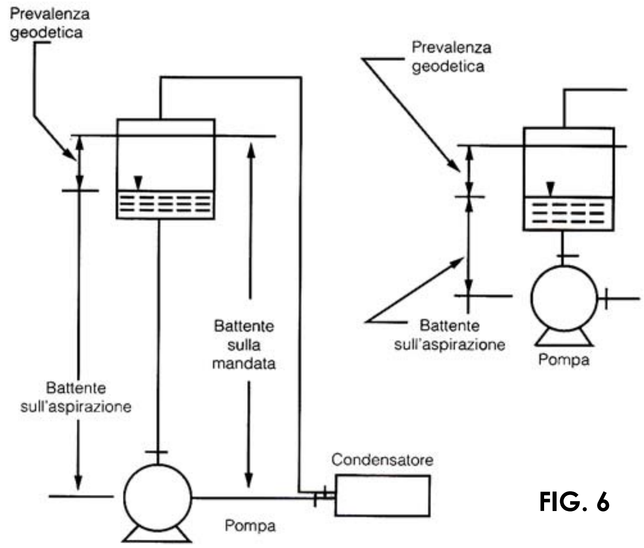


FIG. 6

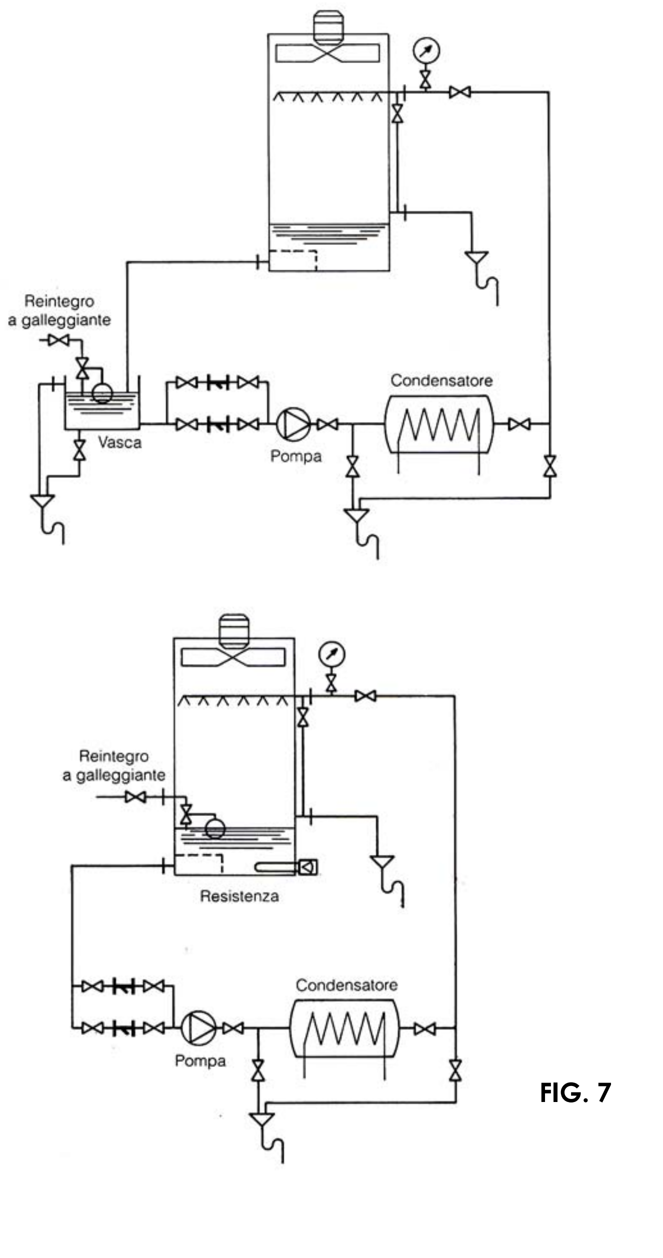


FIG. 7

5. External accumulation water tank
An external water tank should be used, except for very special cases, whenever the tower operation continues during the winter period and the tower is installed outdoor.
The water tank can also be installed inside a building in order to avoid ice formation during off-operationperiods. As a further caution, the water tank can be equipped with thermostat controlled electric heaters. A possible example of the curcuit is shown in fig. 7.
The accumulation water tank is not necessary when the tower is in operation only during summer time. As a caution, howerver, it can be installed an electric heater, with manual or automatic control, to protect against sudden temperature drops in mid-season.
A typical example is shown in fig. 8.

6. Multiple users
In case of multiple users, with variable water flow due either to regulation or intermittence, it is now necessaryto employ an intermediate tank subdivided in two parts: COLD WATER TANK SECTION AND WARM WATER TANK SECTION. There will be a warm water tank section to tower circuit with strictly constant water flow and a cold water water tank section to user circuit with variable waterflow. It is necessary that the warm water to tower circuit pumps and/or the water fan can be controlled from a thermostat sensing the water temperature in cold water tank section.
In case of multiple users, to avoid employing the intermediate tank, it is appropriate to have a regulation by means of deviating 3-way valves in order to have a constant water flow to the tower.
It must be emphatize that the water flow throught the cooling tower must be constant and possibly without intermittence.
The tower flow constance is necessary for a regular water duller operation and it limits the internal corrosion caused by the "wet-dry" effect in the sump tank walls.

7. Cooling towers in parallel
In case of use of several towers in parallel it is necessary to use an intermediate tank.
This can be eliminated if the cooling tower sump tanks are connected by equalizing pipes in order to keepan equal water level in the various towers (see fig. 8 bis).

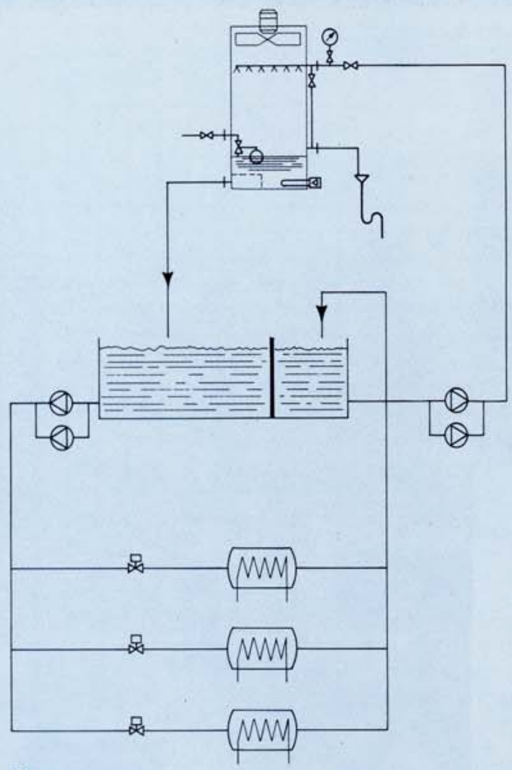


FIG. 8

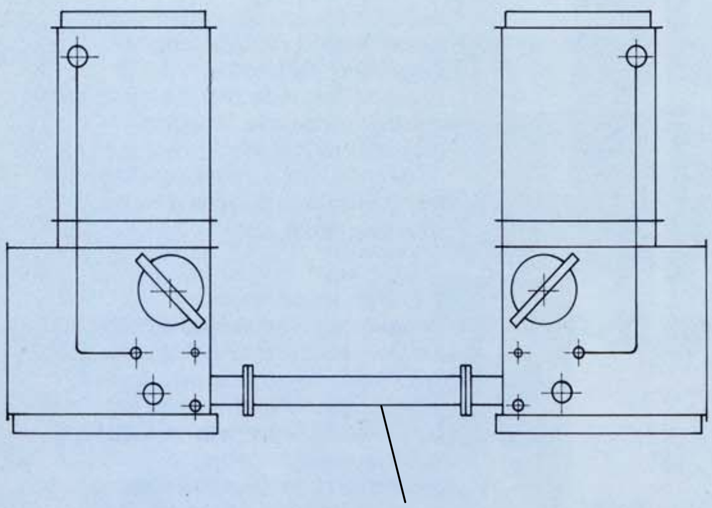


FIG. 8 bis

Very often the reason for a defective tower operation can be found in a improper installation. The main rules to follow are:

1. **Prevent air short-cycling**
   Position the tower on a flat surface, away from walls or roofings that may determinate air short cycles between sction and discharge.

2. **Prevent warm air or fumes inlet**
   The tower should be positioned away from warm air exhausts, kitchen fumes, etc., which causes effects worse even than short-cycling. If at all possible, position the tower near the air conditioning exhaust, orienting the expelled air on the fan section. The lower wet bulb temperature of the expelled air will increase the cooling tower capacity.

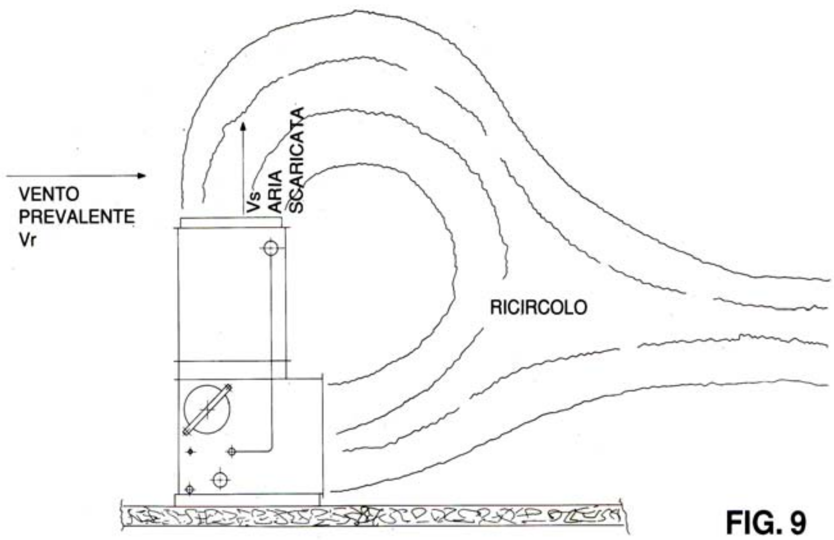


FIG. 9

3. **Beware of prevailing winds**
   The prevailing winds increase the short-cycling risk between discharge and suction air. Tend to bend the discharge air flow in their direction and induce a depression zone on the side opposite to the wind direction. If the fans are located on this opposite side there will be an almost sure short-cycle (see fig. 9). Conversely, if the wind blows directly against the fan section, it may create instability of air flow inside the tower. In these cases the towers should be protected by a wind breaking barrier wich should have a height lower than the tower, and should be positioned at a certain distance.

4. **Respect service clearances**
   The necessary service and operation clearances, as specified in the installations instructions, should be always observed.

5. **Ducted installation**
   If the tower should operate with ducted air intake or air discharge, the motor power and the pulley's drive ratio should be carefully checked to face the duct's pressure drop.

6. **Fog formation**
   In certain ambient air conditions, particularly in winter or in certain mid season periods, there can be fog formation. The probability of fog formation can be checked on the psychrometric graph. When the line that joins the ambient air wet bulb with the tower discharge air wet bulb temperature gets outside the saturation curve, it is probable that fog formation occurs (see fig. 10). Check the site temperature and the tower operation cycles. If fog formation is probable, the tower positioning should not produce obstacles or complaints (example: near heavy traffic roads, residential areas, etc.).

PSYCHROMETRIC GRAPH

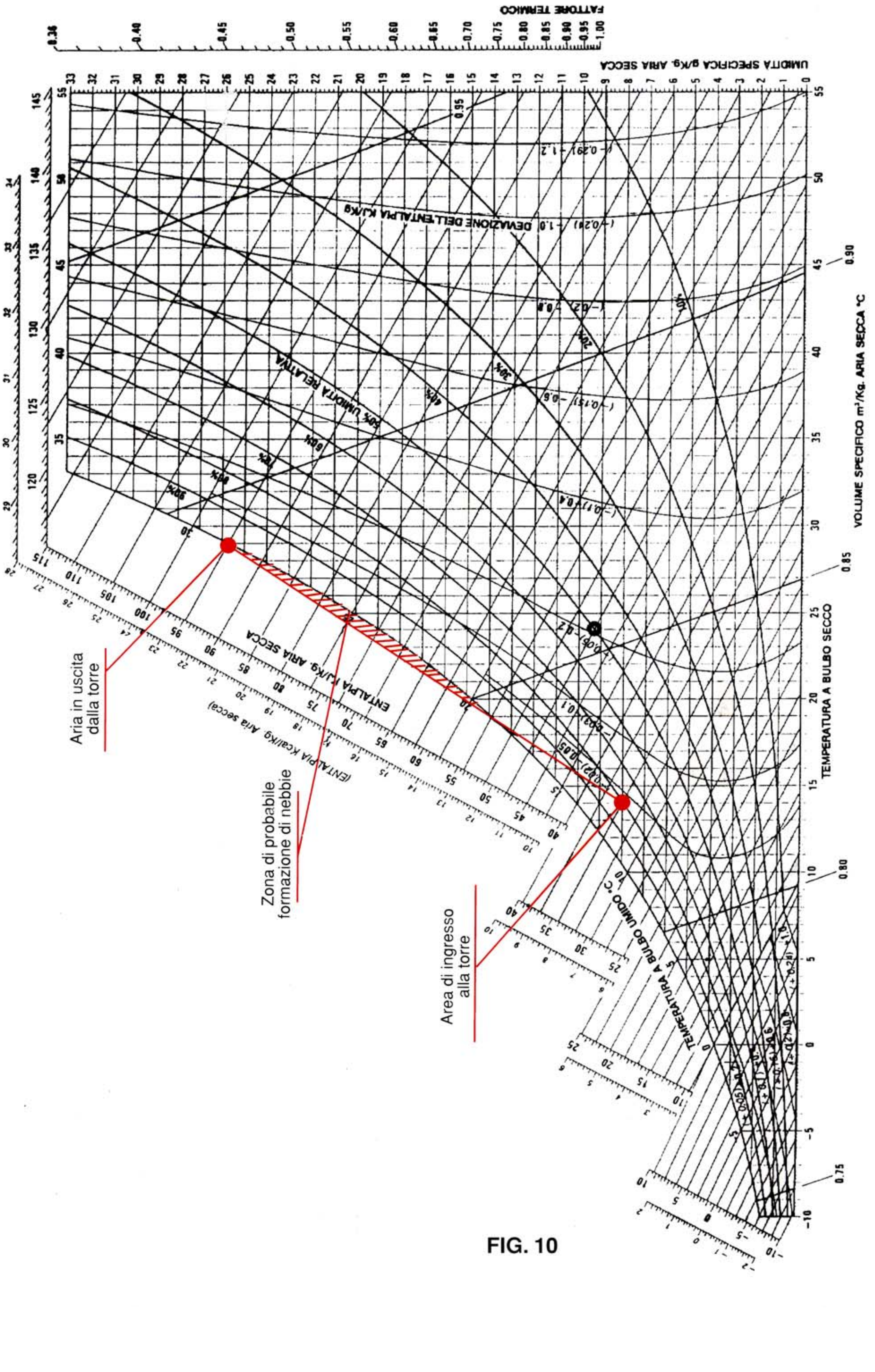


FIG. 10

TOWERS FUNCTIONING AND OPERATING

Hereafter some pratical informations are given for better cooling tower functioning and operating.

1. **Water consumption**
   Generally the cooling towers have a water consumption around 2-4% of the total circulated volume. Theorically the evaporation consumption is about 1% for a water temperature difference of 7°C, but to this it should be added the water consumption due to the bleed-off and the water losses due to the discharge of entrainment.

2. **Bleed-off**
   Bleeding-off a certain water quantity is necessary to reduce the salt concentration in the tank and in the circuit, and to eliminate the possible impurities which tend to accumulate inside the sump tank.
   The quantity of bleed-off water depends from the water hardness: the harder the water, the bigger the water bleed-off.
   For average hardness water, a pratical rule is to have a bleed-off quantity equal to the evaporated quantity, i.e. 1-2%.
   In this way, the salt and impurities concentration will reach a maximum value equal to twice the original value.
   To obtain a higher precision and to calculate the bleed-off flow for various salt concentrations in the water, the following formula can be used:

   bleed-off flow = $L \times C_r/(C_a - C_r) = L_E \times K_B$

   where:
   L_E = water rate evaporated (l/h) [kg/h]. It depends from cooling tower capability or better from rejected heat. At standard conditions the heat evaporation rate is 540 kcal/kg (0,627 kWh/kg). For example the model 12 TCN 100 at standard conditions rejects 392.000 kcal/h (455,8 kW). The evaporation rate is:

$$L_E = \frac{392.000}{540}\left[\frac{kcal}{h}\Big/\frac{kcal}{kg}\right] = \frac{455,8}{0,627}\left[kW\Big/\frac{kW*h}{kg}\right] = 726\ \frac{kg}{h}$$

   C_r = make-up water salt concentration (ppm).

   C_a = recirculated water maximum allowable salt concentration (ppm)

T_{H2O} (°C)	20°	25°	30°	35°	40°	45°	50°	60°	70°
C_a (p.p.m.)	280	240	225	200	175	150	125	110	100

Tabella per determinare il COEFFICIENTE DI BLEED-OFF.

Durezza acqua di reintegro C_r [p.p.m.]	Durezza massima ammissibile [C_a (p.p.m.)]									
	T (°C) C_a (p.p.m.)	20° 280	25° 240	30° 225	35° 200	40° 175	45° 150	50° 125	60° 110	70° 100
75		0,36	0,45	0,5	0,6	0,75	1	1,5	2,15	3
100		0,55	0,71	0,8	1	1,33	2	4	10	-
125		0,8	1,1	1,25	1,66	2,5	5	-	-	-
150		1,15	1,66	2	3	6	-	-	-	-
175		1,66	2,7	3,5	7	-	-	-	-	-
200		2,5	5	8	-	-	-	-	-	-

   Procedine with the example of 12TCN100 model, for wich the evaporatine rate was L_E = 726 kg/h, with make-up water hardness of 15°F (150 p.p.m.) and water inlet temperature of 35°C, from the herewith table we find a coefficient K_B = 3.
   The water bleed-off should be

$$L_B = 3 \times 726 = 2.178 \text{ kg/h (l/h)}$$

   The water consumption wiil be 2.178 + 726 = 2.904 kg/h.
   Using partially softned water to 7,5°F (75 p.p.m.), we will have: $K_B = 0,6 \times L_B = 0,6 \times 726 = 436$ kg/h; the total consumption should be 436 + 726 = 1.162 kg/h.

3. **nominal conditions**
   The cooling towers for confort air conditioning uses are normally selected for standard water temperatures: conventionally it is accepted an entering water of 35°C and a leaving water of 29,5°C. The temperature difference is therefore fixed in 5,5°C. In any case the minimum leaving water temperature cannot be lower than the ambient wet bulb temperature increased by 2-3°C.

As is well known, the cooling tower selection depends from the heat rejection value and from the ambient wet bulb. As far as this is concerned, it must be kept in mind that there may be an increase of its value, for short periods during the peak season, when there is also the peak cooling demand. To prevent the risk of overloading the water chillers, it is advisable to select the cooling tower for a wet bulb temperature about 2°C higher than the site design one. This method, beyond preventing overloads, will determine a lower water chiller energy consumption during the season.
For process cooling in the petrochemical industry, there can be frequently water temperatures of 65-70°C. This may require a replacement of the standard wet deck with the special high temperature one. In case of doubt, consult the Engineering Dept.

WATER TREATMENT

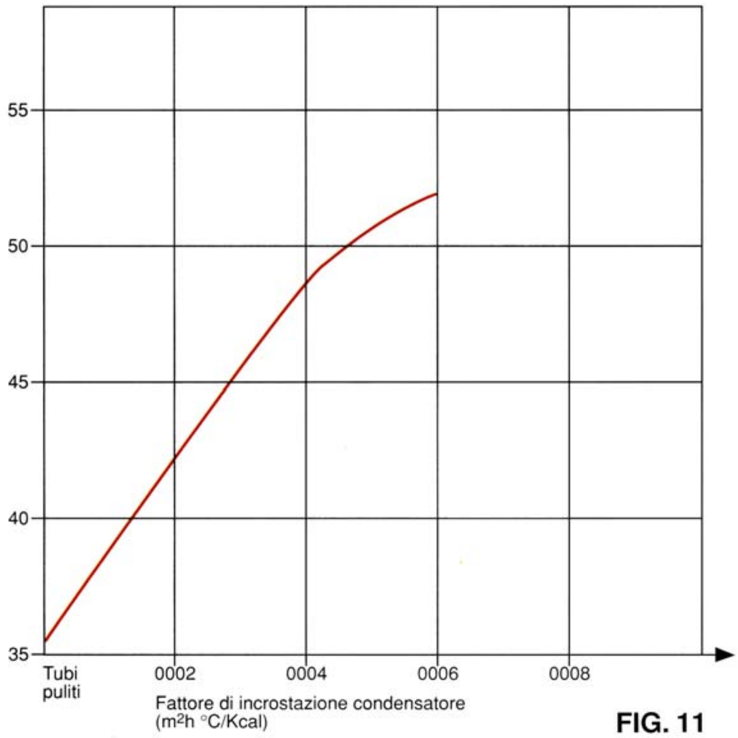


FIG. 11

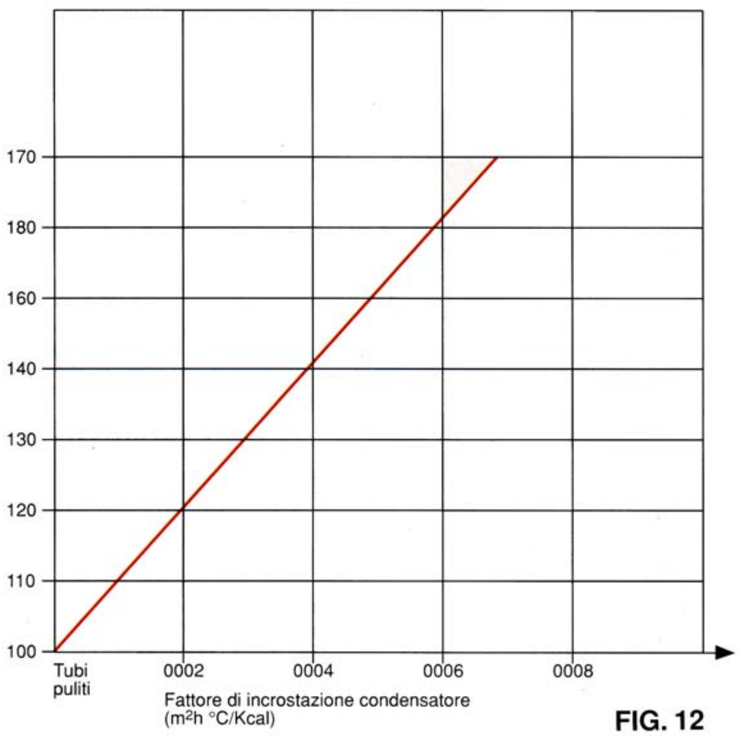


FIG. 12

It is unavoidable, in a cooling tower, the accumulation of air conditioned impurities and the increase of salt concentration in spite of the bleed-off. This is a great handicap for any heat exchange process and penalizes the water chiller operation.
Hereinafter a short description of the main disadvantages and the possible remedies.

1. **Scaling and decrease of refrigerating capacity**
   The hydraulic circuit and the condenser pipes are subjected to scaling when the soluted salts and the gases contained in the water reach their solubility limit and precipitate on the tube walls, on the heat exchange surfaces, etc.
   Scaling not only reduces the useful pipe section, but also creates a thermally insulating layer on the heat exchange surfaces which progressively reduces the water chiller capacity. Furthermore, within the cooling towers there may be a growth of algae and fungi which obstruct the pipes. As an example, in Tab. 2 are shown some typical fouling factors related to the scaling thickness in the pipes which demonstrate the decline of the condenser total thermal transmission coefficient and the percentage surface increase which would be necessary to keep the performance at the originary level.
   Fig. 11 shows a curve giving the increase in the condensing temperature (inside a water cooled condenser) as a function of the fouling factor.
   Fig. 12 gives also the increase in the compressor power absorption as a function of the condenser fouling factor.

2. **Protection against scaling**
   In order to reduces the tube scaling in case of high hardness water, it is possible to use chemical inhibitors which increase the concentration level determining the salt precipitation, particularly Calcium and Magnesium carbonates.
   The most common inhibitors are based on acids, non-organic phosphates and similar substances. Also other methods are however effective, like ion-exchanging rhesins system to decrease the make-up water hardness.
   The problem should be studied on a case by case basis, also from the economical point of wiew, with the assistance of water treatment specialists.

3. **Protection against corrosion**
   The addition in the water of chemical substances like chromates, phosphates, etc. generates a protective film on the metal surface of the whole hydraulic circuit which prevents corrosion.
   The chromates are very effective onhibitors for waters in a wide pH range from about 6,5 upwards.
   With these substances it is necessary to keep with precision the minimum required concentration because, if it goes below the minimum, it can create "pitting" corrosion.
   On the other hand, the chromates are slightly toxic and tend to be eliminated from common use.
   The poliphosphates are not toxic, but tend to favour the growth of algae and fungi.
   Periodical water treatments can be made with Sodium silicates or phosphates and silicates mixtures. It is however always advisable the assistance of a specialist.

4. **Control of algae and fungi growth**
   These microorganisms, as said before, find a very favourable ambient to their growth in the cooling tower sump tank.
   Their growth must be fought with biocide treatment (chlorine or other substances). It is advisable to use two different biocides alternatively to avoid that the microorganism develop a resistance or an immunity to the same agent.

COOLING TOWER SERVICING

For a regular plant operation, a service schedule should be set. We refer to each equipment service manual for specific operation. However hereinafter are listed the main checks that should be carried out on a cooling tower.

Air side
1. check belt tension and belt wear in units with centrifugal fans. Check that the impeller is centred on the shaft and is rigidly fixed without rubbing against the scroll. Check the state of fan of fan and motor bearings and the state of lublification.
2. check the dampe (if any) on the fan discharge.
3. check electric motors and the relative circuits.
4. check the state of the moisture eliminators, removing any obstruction.
5. check the state of the wet deck. Control its integrity and that it is not obstructed by dirt or by solid particles.

Water side
1. clean the sump tank at least once a month; clean also the filter on the water outlet.
2. control nozzle cleanliness at seasonal start-up. Periodically check that the pressure at the nozzles is as per service manual indications.
3. check the bleed-off and control its correct operation at the supplier's instructions.
4. check the water softener operation, if any, according to supplier's instructions.
5. use, according to necessity, the biocides to eliminate algae and fungi.
6. verify the cooling tower structure to note rust or corrosion. In that case remove rust or corrosion stains, restoring with the indicated paints the protective layer.

COOLING TOWER SELECTION

The THERMAC cooling tower selection is based on the Flow Factor method which allows a precise and quick selection.
To select it is necessary to know:
- ambient wet bulb temperature (T b.u.);
- entering water temeperature (Te);
- temperature difference betwen entering and leaving water (ΔT);
- water flow to be cooled (l/h).

The Flow Factor are tabulated for the most frequent conditions. For out of standard conditions, THERMAC Engineering Dept. can supply a computerized selection.

Selection example

Data:
- environment wet bulb temperature: 23°;
- inlet water temperature: 35°C;
- temperature difference between inlet and outlet water: 5,5°C
- Water flow to be cooled: 100.000 l/h

Solution
In the Range Factor Table we find the right value for the external wet bulb temperature of 23°C. This value is calculated in function of the water difference temperature of 5,5°C and of the water inlet temperature of 35°C. So we have a Range factor of 2,33.

Now we can access the graph to select the Cooling Tower size and model, according the water flow of 100.000 l/h and the Range Factor, already computed, of 2,33. On the horizontal graph axis we find the water flow, while the Range Factor are shown on the vertical one.
According the two values of 100.000 l/h and 2.33, we find, on the graph, the following tower models: 12TCN – 10DTCN – 15TA.
On the horizontal axis we find the water flow value of 100.000 l/h and going to the top vertically, crossing with the Range Factor Value of 2,33 we find that the crossing point is near to the half curve for the 12TCN 100 - 10DTCN 120 - 15TA 120 models.
Presuming we need a centrifugal-fan model, we should discharge the 15TA 120 model. Then we can cut our selection between the 12TCN 100 and the 10DTCN 120 models. On principle, in this kind of circumstaces, we have to choose the bigger size (10DTCN 120 model, in the exemple). But there is a sensitive difference in cost between the two models, because the 10DTCN models have fans on each side, whereas the 12TCN models have single-side fans. It could be useful, in this case, to review the project data, and verify if it is possible to fall within the smaller size. We have the following option to check:

1. Wet bulb air temperature.
   How was it setted? Is it possible a reduction down to 1°C from the initial value? In thi case the Range Factor will increase to 2,55, so the previews crossing point would fall nearly to the 12TCN 100 graph.

2. Water temperature difference.
   Is it possible reduce the temperature gap to 5°C instead of 5.5°C? If it is, the Range Factor increases to 2,62 and the selection would cross exactly the 12TCN 100 graph.

3. If the entire corrections are not possible, verify if it is possible, at least, a partial correction of both wet bulb temperature and water inlet temperature difference; in example, if a correction of the wet bulb temperature down to 0,5°C less and 0,25°C less in the inlet water temperature difference will confirm the 12TCN 100 selection.

Generally it is possible to find a satisfactory compromise. In those more binding cases, refer to our Technical offices for an aimed selection, done with the aid of the computer.

TECHICAL DATA

Model	nominal power		water flow		air flow		on-board power	weight (operating	weight (empty)
	kcal/h	kW	l/h	l/s	m /h	l/s	kW	kg	kg
4TE 5	19.600	22,8	3.500	0,97	3.500	972,2	0,55	470	220
4TE 7,5	29.230	34	5.220	1,45	4.000	1111,1	0,55	470	220
4TE 10	39.200	45,6	7.000	1,94	7.000	1944,4	0,75	475	263
4TE 15	58.520	68	10.450	2,9	7.500	2083,3	0,75	475	263
15TA 120	470.400	547	84.000	23,33	34.500	9583,3	3	2.730	1.730
15TA 140	543.200	631,6	97.000	26,94	42.000	11.666,60	4	2.760	1.760
15TA 160	616.000	716,3	110.000	30,55	48.000	13.333,30	4	2.780	1.780
15TA 180	700.000	814	125.000	34,72	54.000	15.000	5,5	2.840	1.840
15TA 200	767.200	892	137.000	38,05	60.000	16.666,60	7,5	2.860	1.860
15TA 240	912.800	1.061,40	163.000	45,27	69.000	19.166,60	2 x 3,0	5.130	3.130
15TA 280	1.064.000	1.237,20	190.000	52,77	84.000	23.333,30	2 x 4,0	5.180	3.180
15TA 320	1.232.000	1.432,50	220.000	61,11	96.000	26.666,30	2 x 4,0	5.230	3.230
15TA 360	1.400.000	1.628,00	250.000	69,44	108.000	30.000,00	2 x 5,5	5.350	3.350
15TA 400	1.512.000	1.758,00	270.000	75	120.000	33.333,30	2 x 7,5	5.400	3.420
15TA 480	1.848.000	2.148,80	330.000	91,66	144.000	40.000,00	3 x 4,0	7.650	4.650
15TA 600	2.324.000	2.702,00	415.000	115,27	180.000	50.000,00	3 x 7,5	7.850	4.850
15TA 720	2.800.000	3.255,80	500.000	138,88	216.000	60.000,00	4 x 5,5	10.131	6.130
15TA 800	3.108.000	3.614,00	555.000	154,16	240.000	66.666,60	4 x 7,5	10.320	6.320
15TA 1000	3.864.000	4.493,00	690.000	191,66	280.000	77.777,70	4 x 9,0	10.720	6.720
12TCN 20	78.400	91,2	14.000	3,88	8.500	2.631,10	1,1	655	405
12TCN 25	95.200	110,7	17.000	4,72	10.000	2.777,70	1,5	660	410
12TCN 30	117.600	136,7	21.000	5,83	11.500	3.194,40	2,2	670	420
12TCN 35	140.000	162,8	25.000	6,94	13.000	36.11,1	3	680	480
12TCN 40	154.000	179	27.500	7,63	13.500	3.750,00	3	685	435
12TCN 45	173.600	201,8	31.000	8,61	18.500	5.138,80	2,2	1.210	730
12TCN 50	196.000	228	35.000	9,72	21.000	5.833,30	3	1.220	740
12TCN 60	235.200	273,5	42.000	11,66	22.500	6.250,00	4	1.235	755
12TCN 70	274.400	319	49.000	13,61	26.500	7.361,10	5,5	1.255	775
12TCN 80	308.000	358	55.000	15,27	27.500	7.638,80	5,5	1.260	780
12TCN 90	350.000	407	62.500	17,36	33.500	9.305,50	7,5	1.580	955
12TCN 100	392.000	455,8	70.000	19,44	37.500	10.416,60	7,5	1.585	960
10DTCN 120	470.400	547	84.000	23,33	45.000	12.500	2 x 4,0	2.190	1425
10DTCN 140	543.200	631	97.000	26,94	53.000	14.722,20	2 x 5,5	2.230	1465
10DTCN 160	616.000	716	110.000	30,55	55.000	15.277,70	2 x 5,5	2.235	1470
10DTCN 180	700.000	814	125.000	34,72	67.000	18.611,10	2 x 7,5	2.745	1755
10DTCN 200	767.200	892	137.000	38,05	75.000	20.833,30	2 x 7,5	2.750	1760
10DTCN 240	912.800	1.061,00	163.000	45,27	90.000	25.000,00	4 x 4,0	4.300	2800
10DTCN 280	1.064.000	1.237,00	190.000	52,27	106.000	29.444,40	4 x 5,5	4.370	2870
10DTCN 320	1.232.000	1.432,00	220.000	61,11	110.000	30.555,50	4 x 5,5	4.380	2880
10DTCN 360	1.400.000	1.628,00	250.000	69,44	134.000	37.222,20	4 x 7,5	5.440	3550
10DTCN 400	1.512.000	1.758,00	270.000	75	150.000	41.666,60	4 x 7,5	5.450	3560
LCT 202	766.200	891	136.000	37,77	68.000	18.888,80	7,5	3.900	2475
LCT 242	912.800	1.061,40	163.000	45,27	87.000	24.166,60	15	3.970	2545
LCT 282	1.064.000	1.237,20	190.000	52,77	95.000	26.388,80	18,5	4.000	2575
LCT 303	1.149.300	1.336,40	204.000	56,66	102.000	28.333,30	11	5.860	3710
LCT 363	1.379.160	1.603,70	244.000	67,77	130.000	36.250,00	18,5	5.900	3750
LCT 404	1.532.400	1.781,80	272.000	75,55	136.000	37.777,70	2 x 7,5	7.800	4910
LCT 484	1.838.880	2.138,20	326.000	90,55	174.000	48.333,30	2 x 15	7.900	5010
LCT 564	2.145.360	2.494,60	380.000	105,55	190.000	52.777,70	2 x 18,5	8.000	5110

Nota bene:

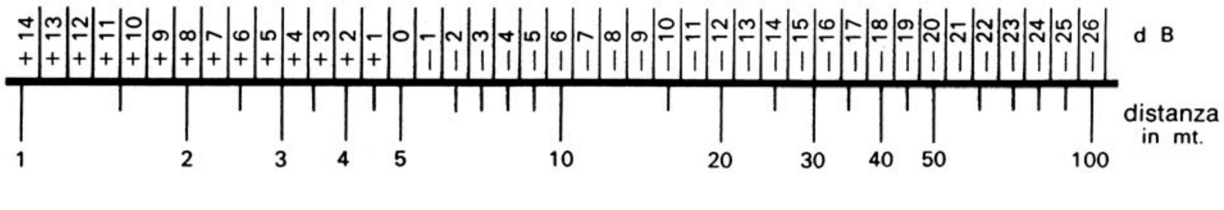
1. table capabilities are referred to: Water inlet temperature: 35°C; Water out temperature: 29,4°c; Wet bulb temperature: 25,6°c
2. the on-board power gives an outlet air flow static pressure of 50 Pa (5 mm c.d.a.)
3. water rate is referred to a spray noozles operatine pressare of 30 kPa (3 m.c.d. ; 0,3 bar)

SOUND PRESSURE LEVELS PER OCTAVE BAND TO 5m (dB)

Model	Hz							NC Criteria
	63	125	250	500	1000	2000	4000	
4TE 5	49	50	51	51	49	47	43	49
4TE 7,5	50	51	52	52	50	48	44	50
4TE 10	52	53	54	54	52	50	46	52
4TE 15	53	54	55	55	53	51	47	53
15TA 120	58	62	69	66	63	54	48	63
15TA 140	59	63	70	67	64	55	49	64
15TA 160	60	64	71	68	65	56	50	65
15TA 180	61	65	72	69	66	57	51	66
15TA 200	62	66	73	70	67	58	52	67
15TA 240	61	65	72	69	66	57	51	66
15TA 280	62	66	73	70	67	58	52	67
15TA 320	63	67	74	71	68	59	53	68
15TA 360	64	68	75	72	69	60	54	69
15TA 400	65	69	76	73	70	61	55	70
15TA 480	66	69	76	73	70	61	55	70
15TA 600	67	71	78	75	72	63	57	72
15TA 720	67	71	78	75	72	63	57	72
15TA 800	68	72	79	76	73	64	58	73
15TA 1000	69	73	80	77	74	65	59	75
12TCN 20	63	62	69	66	63	54	48	52
12TCN 25	64	63	70	67	64	55	49	53
12TCN 30	64	63	70	67	64	55	49	53
12TCN 35	65	64	71	68	65	56	50	54
12TCN 40	65	64	71	68	65	56	50	54
12TCN 45	66	65	72	69	66	57	51	55
12TCN 50	67	66	73	70	67	58	52	56
12TCN 60	67	66	73	70	67	58	52	56
12TCN 70	68	67	74	71	68	59	53	57
12TCN 80	68	67	74	71	68	59	53	57
12TCN 90	69	68	75	72	69	60	54	58
12TCN 100	70	69	76	73	70	61	55	59
10DTCN 120	70	69	76	73	70	61	55	59
10DTCN 140	71	70	77	74	71	62	56	60
10DTCN 160	71	70	77	74	71	62	56	60
10DTCN 180	72	71	78	75	72	63	57	61
10DTCN 200	73	72	79	76	73	64	58	62
10DTCN 240	73	72	79	76	73	64	58	62
10DTCN 280	74	73	80	77	74	65	59	63
10DTCN 320	75	74	81	78	75	66	60	64
10DTCN 360	75	74	81	78	75	66	60	64
10DTCN 400	76	75	82	79	76	67	61	65
LCT 202	62	61	58	56	55	53	49	55
LCT 242	67	66	63	61	60	58	54	60
LCT 282	70	69	66	64	63	61	57	63
LCT 303	63	62	59	57	56	54	50	56
LCT 363	68	67	64	62	61	59	55	61
LCT 404	65	64	61	59	58	56	52	58
LCT 484	70	69	66	64	63	61	57	63
LCT 564	73	72	69	67	66	64	60	66

Nota bene:

1. Sound pressare levels are an average between each octave band acoustic value calculated for a distance of 5m from the tower.
2. the N.C. are referred to N.C. graph immediatly superior to tower noise graph.
3. noise levels depend on tower positioning. For special positioning refer to our Offices.
4. Sound levels change with the changing of distance from noise source, accordino the table below:



RANGE FACTOR

TBU = w.b. environment Temperature °C

Te = water inlet temperature °C

Δt = difference between Inlet temperature and outlet temperature

TBU	30°C						29°C					
Δt °C / Te °C	4	5	5,5	6	7	8	4	5	5,5	6	7	8
44	5,40	4,00	3,70	3,38	2,85	2,40	5,60	4,18	3,80	3,50	2,92	2,50
43	4,85	3,70	3,42	3,05	2,55	2,10	5,20	4,00	3,60	3,25	2,65	2,30
42	4,50	3,45	3,20	2,80	2,30	1,88	4,60	3,65	3,38	2,98	2,42	2,10
41	4,10	3,15	2,75	2,52	2,00	1,52	4,30	3,37	3,00	2,70	2,23	1,80
40	3,70	2,75	2,45	2,15	1,60	1,15	3,90	3,04	2,62	2,35	1,90	1,41
39	3,20	2,35	2,04	1,80	1,18	-	3,60	2,65	2,30	2,05	1,50	1,05
38	2,70	1,96	1,58	1,30	-	-	3,10	2,26	1,90	1,68	1,08	-
37	2,25	1,45	1,07	-	-	-	2,58	1,85	1,48	1,20	-	-
36	1,63	0,93	-	-	-	-	2,08	1,3	0,98	-	-	-

W.B.T.	28°C						27°C						26°C					
Δt °C / Te °C	4	5	5,5	6	7	8	4	5	5,5	6	7	8	4	5	5,5	6	7	8
40	4,25	3,25	2,90	2,60	2,10	1,70	4,35	3,50	3,10	2,88	2,35	1,90	4,62	3,60	3,20	2,95	2,45	2,05
39	3,75	2,92	2,60	2,30	1,83	1,38	4,00	3,11	2,90	2,50	2,03	1,61	4,22	3,40	3,00	2,65	2,20	1,82
38	3,40	2,55	2,25	1,90	1,46	0,95	3,70	2,85	2,45	2,20	1,70	1,30	3,90	3,01	2,60	2,35	1,95	1,48
37	2,95	2,15	1,86	1,62	0,98	-	3,30	2,43	2,12	1,88	1,40	0,85	3,50	2,60	2,38	2,08	1,60	1,15
36	2,50	1,75	1,42	1,12	-	-	2,83	2,05	1,82	1,48	0,97	-	3,10	2,32	2,05	1,75	1,35	0,80
35	2,00	1,26	0,85	-	-	-	2,40	1,65	1,35	1,05	-	-	2,61	1,98	1,64	1,40	0,85	-
34	1,45	0,70	-	-	-	-	1,90	1,23	0,78	-	-	-	2,32	1,60	1,22	0,96	-	-
33	0,85	-	-	-	-	-	1,40	-	-	-	-	-	1,80	1,05	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	1,30	-	-	-	-	-

RANGE FACTOR

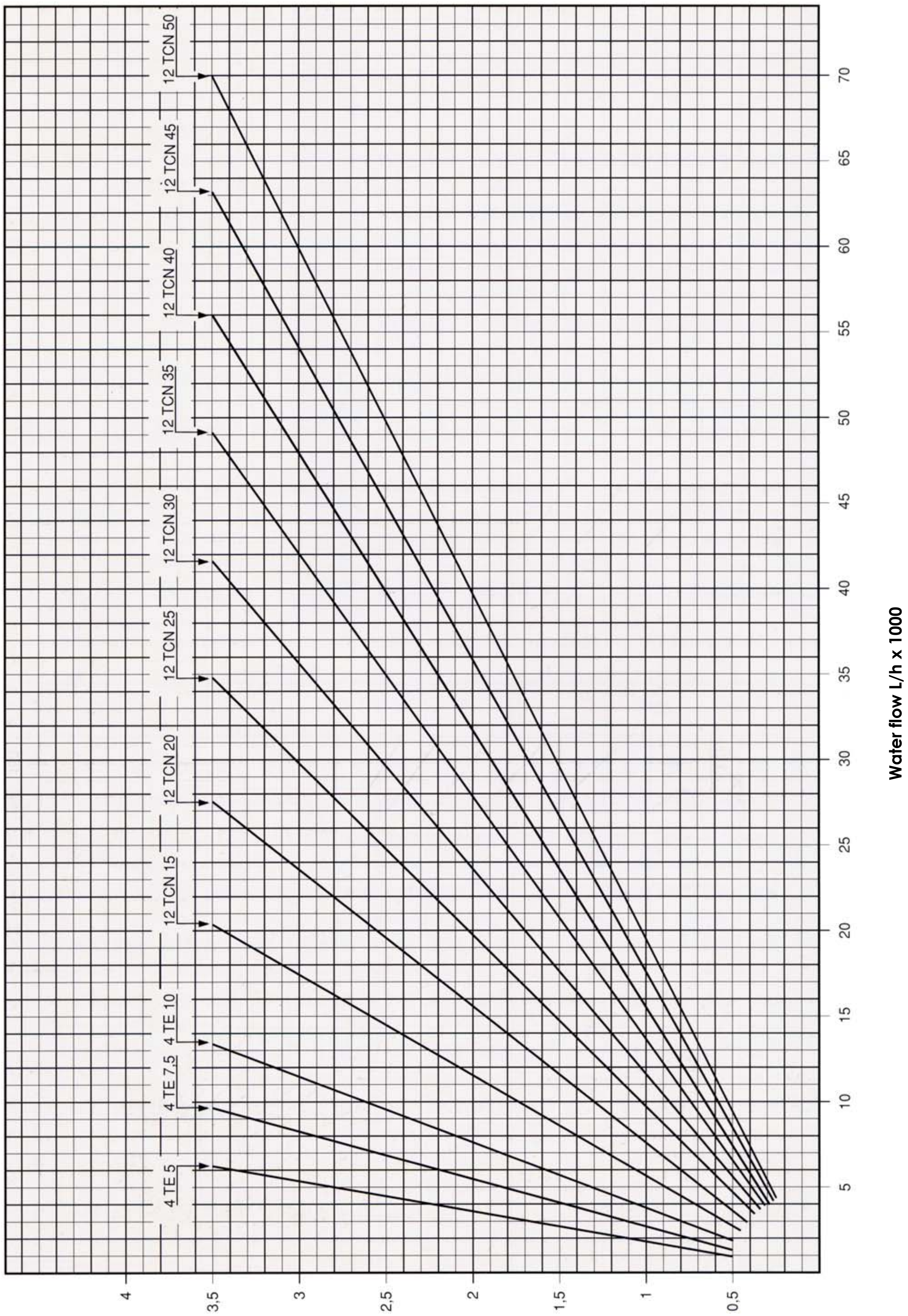
W.B.T.	25°C						24°C						23°C					
Δt °C / Te °C	4	5	5,5	6	7	8	4	5	5,5	6	7	8	4	5	5,5	6	7	8
40	4,80	3,70	3,45	3,12	2,55	2,18	5,00	3,90	3,54	3,22	2,67	2,32	5,10	4,05	3,65	3,35	2,85	2,52
39	4,35	3,51	3,22	2,85	2,38	1,93	4,65	3,65	3,41	3,08	2,55	2,15	4,80	3,82	3,48	3,12	2,60	2,25
38	4,08	3,22	2,85	2,55	2,10	1,70	4,30	3,45	3,10	2,75	2,23	1,93	4,40	3,55	3,25	2,90	2,42	2,05
37	3,70	2,85	2,55	2,28	1,82	1,41	3,95	3,20	2,80	2,50	2,02	1,60	4,12	3,42	3,02	2,70	2,20	1,81
36	3,40	2,55	2,22	1,98	1,48	1,08	3,70	2,75	2,45	2,20	1,71	1,31	3,90	3,08	2,66	2,34	1,93	1,54
35	2,98	2,20	1,95	1,67	1,15	-	3,28	2,42	2,15	1,92	1,45	1,01	3,52	2,62	2,33	2,10	1,62	1,38
34	2,52	1,90	1,54	1,30	-	-	2,88	2,08	1,83	1,62	1,10	-	3,10	2,35	2,07	1,82	1,35	0,95
33	2,10	1,46	1,15	-	-	-	2,40	1,78	1,45	1,22	-	-	2,80	2,05	1,77	1,50	1,01	-
32	1,70	0,97	-	-	-	-	2,07	1,38	1,06	-	-	-	2,32	1,70	1,40	1,10	-	-

TBU = w.b. environment Temperature °C   Te = water inlet temperature °C

Δt = difference between Inlet temperature and outlet temperature

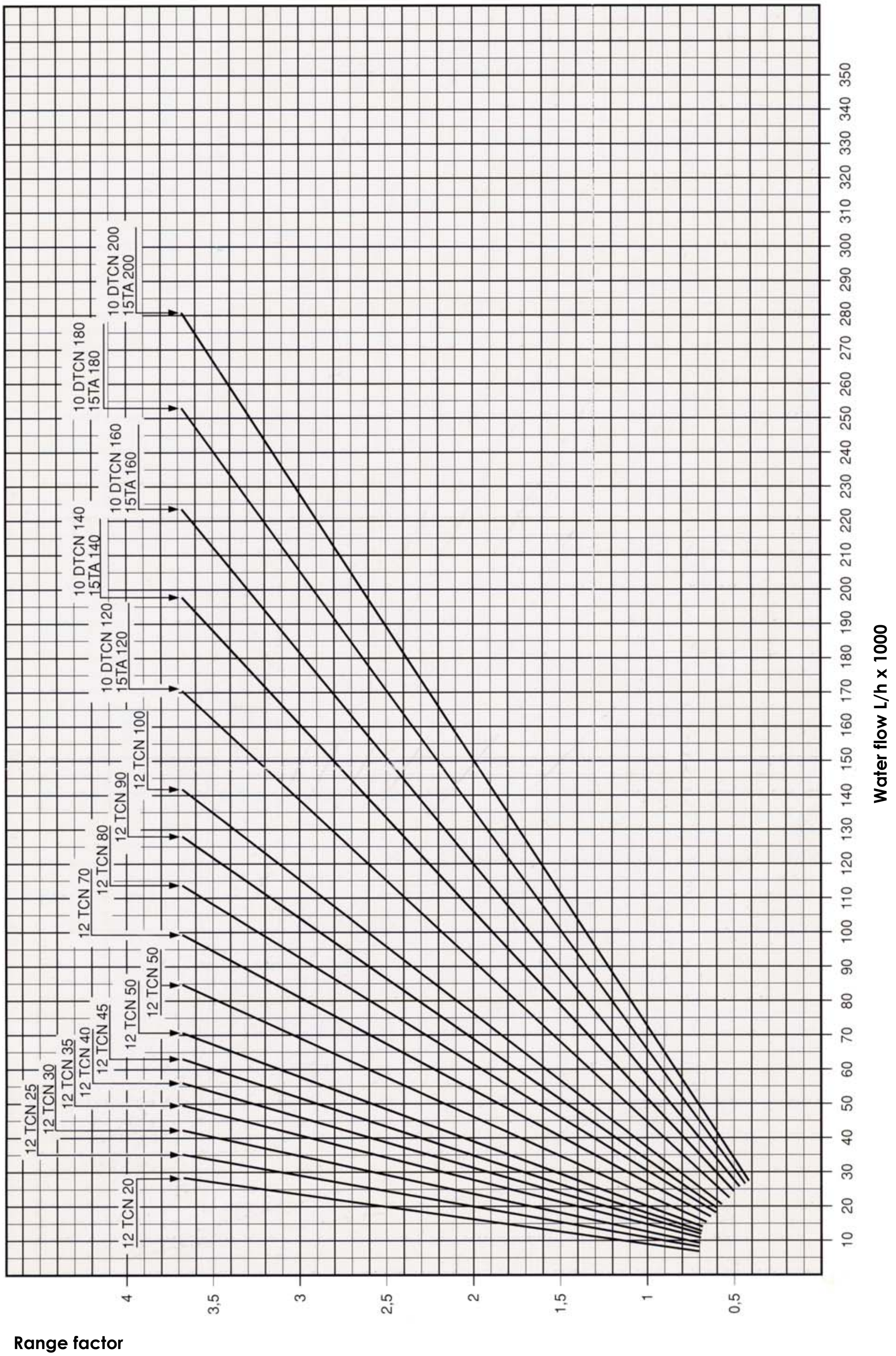
W.B.T.	22°C						21°C						20°C					
Δt °C / Te °C	4	5	5,5	6	7	8	4	5	5,5	6	7	8	4	5	5,5	6	7	8
38	4,65	3,65	3,30	3,08	2,60	2,20	4,80	3,80	3,45	3,20	2,62	2,30	4,98	3,90	3,47	3,20	2,70	2,40
37	4,30	3,45	3,16	2,80	2,33	1,95	4,33	3,58	3,25	2,92	2,42	2,10	4,70	3,68	3,35	3,02	2,60	2,22
36	4,05	3,24	2,84	2,55	2,08	1,71	4,08	3,22	3,10	2,75	2,20	1,92	4,38	3,45	3,19	2,85	2,35	2,02
35	3,75	2,95	2,55	2,30	1,85	1,45	3,90	3,10	2,75	2,43	2,00	1,63	4,02	3,20	2,90	2,58	2,15	1,78
34	3,45	2,55	2,25	2,05	1,55	1,22	3,64	2,78	2,43	2,20	1,73	1,40	3,78	2,98	2,65	2,35	1,92	1,52
33	3,10	2,25	1,98	1,72	1,33	0,86	3,25	2,43	2,18	1,92	1,48	1,12	3,45	2,65	2,32	2,08	1,67	1,30
32	2,60	1,95	1,67	1,41	0,98	-	2,85	2,15	1,90	1,63	1,14	0,77	3,15	2,30	2,07	1,84	1,40	1,11
31	2,22	1,63	1,30	-	-	-	2,51	1,82	1,54	1,35	0,86	-	2,65	2,05	1,80	1,54	1,15	0,70
30	1,90	-	-	-	-	-	2,06	1,48	1,23	0,98	-	-	2,30	1,75	1,50	1,28	-	-

SELECTION GRAPH 4TE ÷12TCN 50

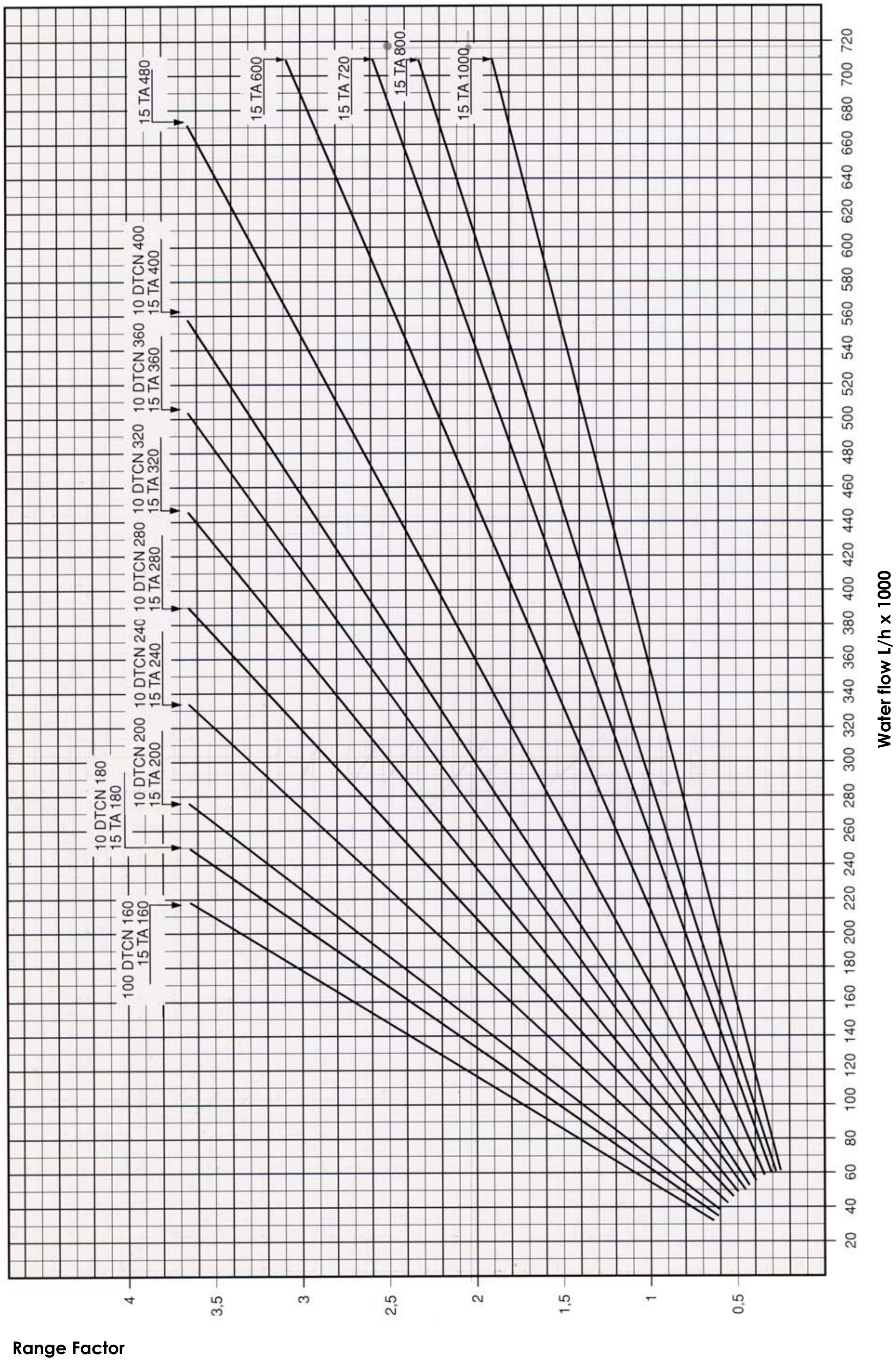


Range factor

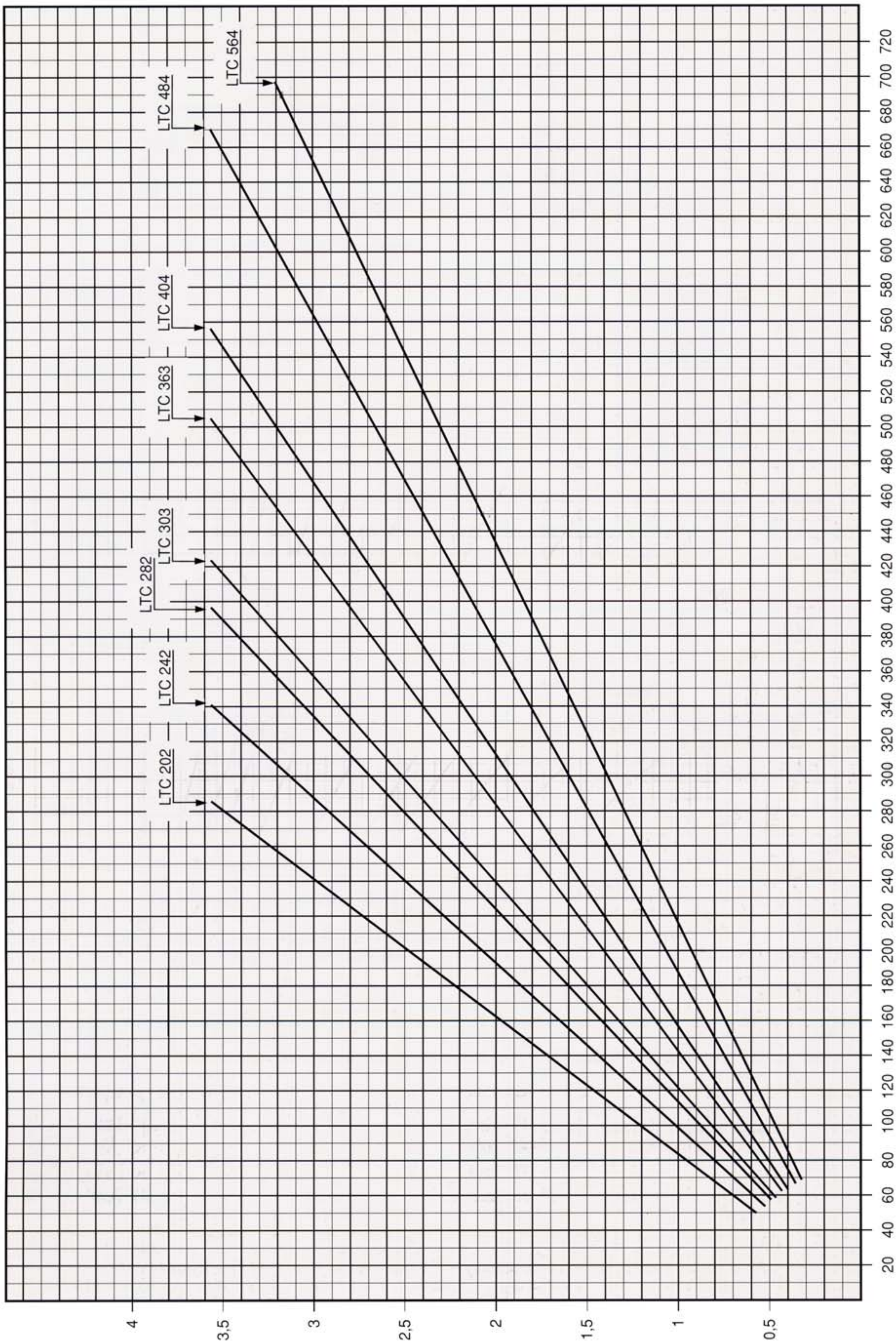
SELECTION GRAPH 12TCN 20 ÷ 10CTCN 200
15TA 120 ÷ 15TA 200



SELECTION GRAPH 10DTCN 160 ÷ 10DTCN 400
15TA 160 ÷ 15TA 1000



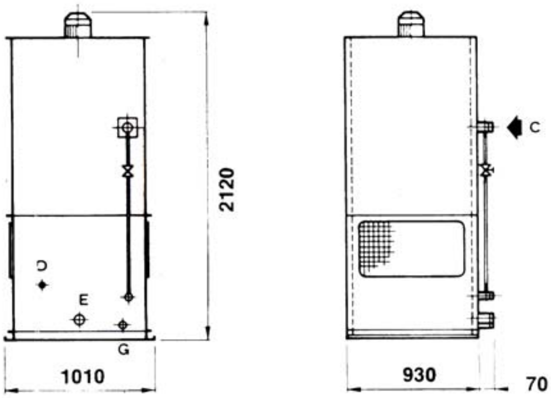
SELECTION GRAPH LCT 202 ÷ LCT 564



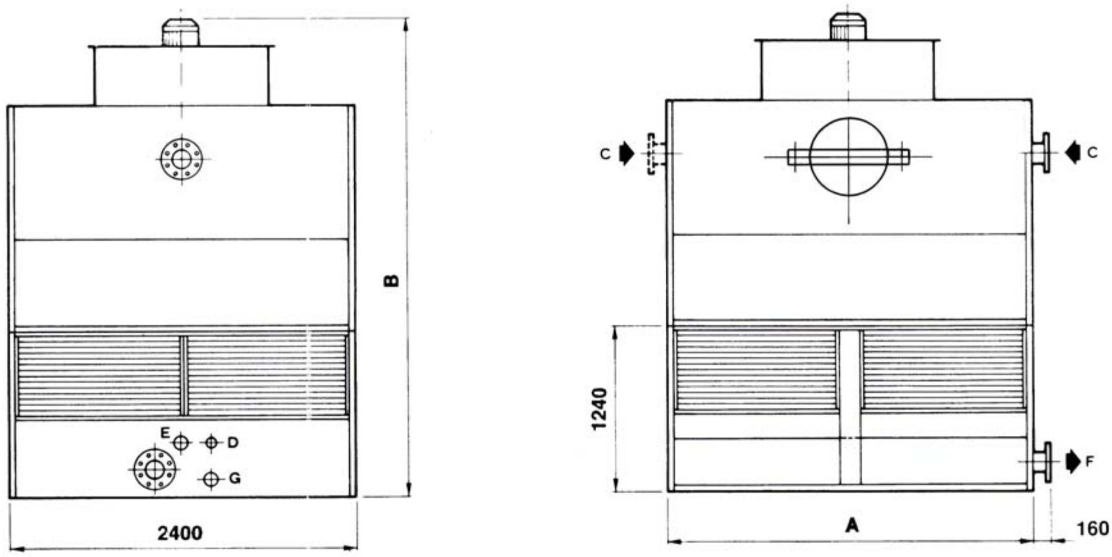
Water Flow L/h x 1000

Range Factor

DIMENSIONS (mm) 4TE – 15TA

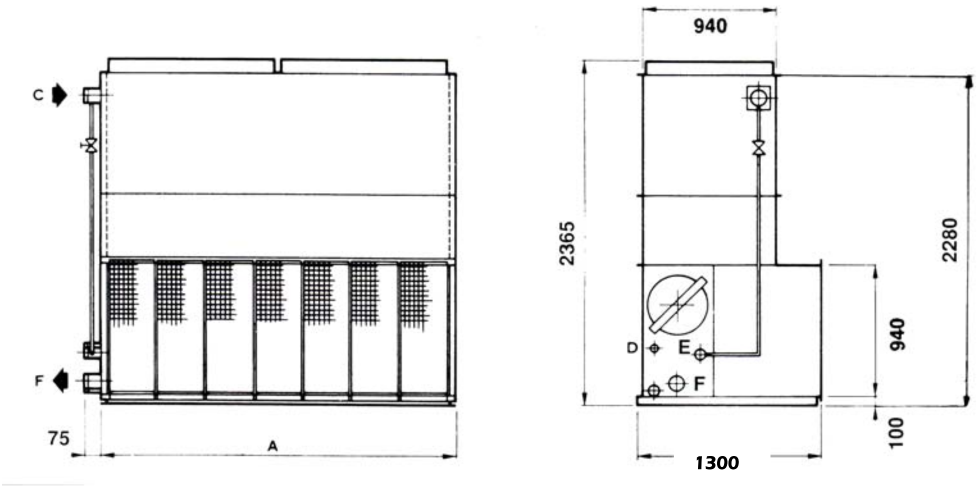


Model	C Water inlet	D Water make-up	E Water outlet	G Drain
4TE 5	2"	½"	2"	1½"
4TE 7,5	2"	½"	2"	1½"
4TE 10	2"	½"	2"	1½"
4TE 15	2"	½"	2"	1½"

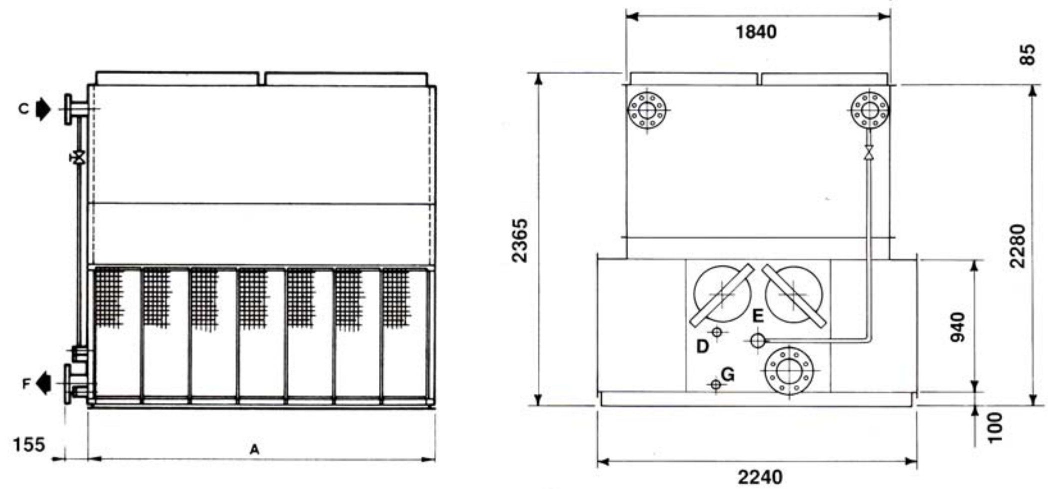


Model	A	B	C Water Inlet	D Water make-up	E overflow	F Water Outlet	G Drain
15TA 120	2540	3150	DN 150	1¼"	3"	DN 150	3"
15TA 140	2540	3150	DN 150	1¼"	3"	DN 150	3"
15TA 160	2540	3150	DN 150	1¼"	3"	DN 150	3"
15TA 180	2540	3370	DN 150	1¼"	3"	DN 150	3"
15TA 200	2540	3370	DN 150	1¼"	3"	DN 150	3"
15TA 240	5000	3150	DN 200	2"	3"	DN 200	3"
15TA 280	5000	3150	DN 200	2"	3"	DN 200	3"
15TA 320	5000	3150	DN 200	2"	3"	DN 200	3"
15TA 360	5000	3370	DN 200	2"	3"	DN 200	3"
15TA 400	5000	3370	DN 200	2"	3"	DN 200	3"
15TA 480	7460	3150	2 x DN 150	2"	4"	DN 200	3"
15TA 600	7460	3370	2 x DN 150	2"	4"	DN 200	3"
15TA 720	9920	3150	2 x DN 200	2"	4"	DN 200	3"
15TA 800	9920	3370	2 x DN 200	2"	4"	DN 200	3"
15TA 1000	9920	3370	2 x DN 200	2"	4"	DN 200	3"

DIMENSIONS (mm) 12TCN – 10DTCN

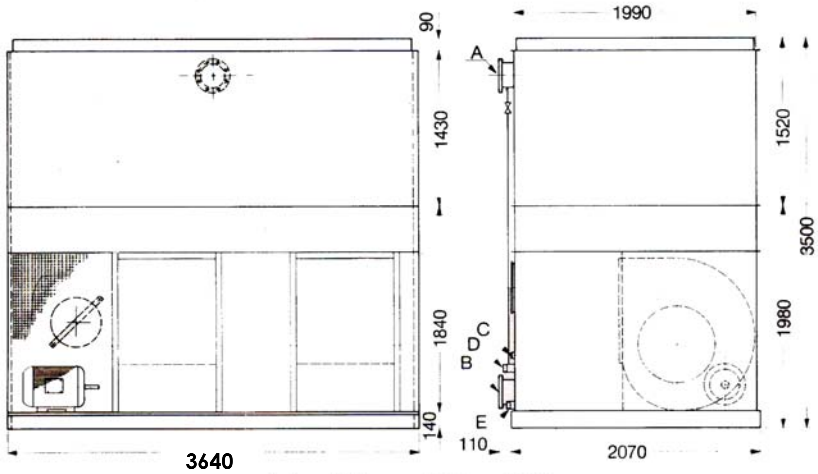


Model	A	C Water inlet	D Water make-up	E Overflow	F Water outlet	G Drain
12TCN 20	1276	3"	¾"	2"	3"	2"
12TCN 25	1276	3"	¾"	2"	3"	2"
12TCN 30	1276	3"	¾"	2"	3"	2"
12TCN 35	1276	3"	¾"	2"	3"	2"
12TCN 40	1276	3"	¾"	2"	3"	2"
12TCN 45	2476	4"	¾"	2"	4"	2"
12TCN 50	2476	4"	¾"	2"	4"	2"
12TCN 60	2476	4"	¾"	2"	4"	2"
12TCN 70	2476	4"	¾"	2"	4"	2"
12TCN 80	2476	4"	¾"	2"	4"	2"
12TCN 90	3076	4"	¾"	2"	4"	2"
12TCN 100	3076	4"	¾"	2"	4"	2"

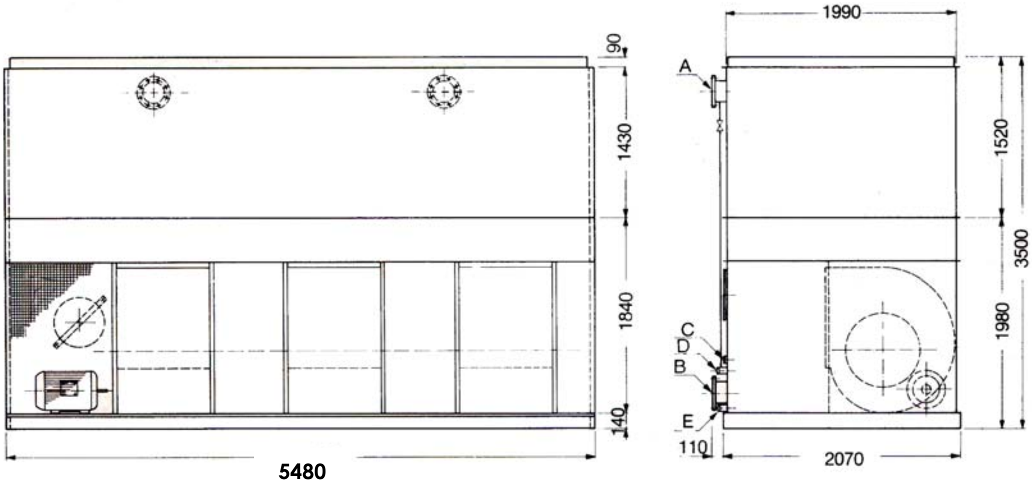


Model	A	C Water Inlet	D Water make-up	E overflow	F Water outlet	G Drain
10DTCN 120	2476	DN 100	1 ¼"	3"	DN 150	2"
10DTCN 140	2476	DN 100	1 ¼"	3"	DN 150	2"
10DTCN 160	2476	DN 100	1 ¼"	3"	DN 150	2"
10DTCN 180	3076	DN 100	1 ¼"	3"	DN 150	2"
10DTCN 200	3076	DN 100	1 ¼"	3"	DN 150	2"
10DTCN 240	4952	DN 125	2"	3"	DN 200	2"
10DTCN 280	4952	DN 125	2"	3"	DN 200	2"
10DTCN 320	4952	DN 125	2"	3"	DN 200	2"
10DTCN 360	6152	DN 125	2"	3"	DN 200	2"
10DTCN 400	6152	DN 125	2"	3"	DN 200	2"

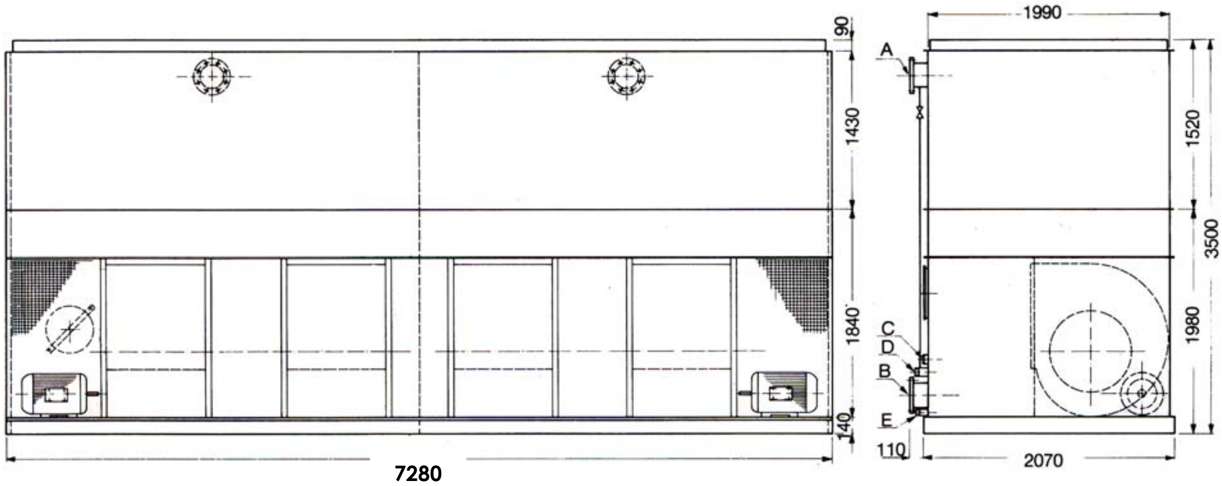
DIMENSIONI IN mm LCT



Modulo di base 202 ÷ 282



Modulo di base 303 ÷ 363



Modulo di base 404 ÷ 564

Model	A Water inlet	B Water outlet	C Water make-up	D Overflow	E D
LCT 202	DN 200	DN 200	2”	3”	3”
LCT 242	DN 200	DN 200	2”	3”	3”
LCT 282	DN 200	DN 200	2”	3”	3”
LCT 303	2 x DN 200	DN 200	2”	3”	3”
LCT 363	2 x DN 200	DN 200	2”	3”	3”
LCT 404	2 x DN 200	DN 250	2”	4”	3”
LCT 484	2 x DN 200	DN 250	2”	4”	3”
LCT 564	2 x DN 200	DN 250	2”	4”	3”

Note: modular configuration has the same single-module depth and height, and a total length equal to single module length multiplied by the module number. I.E.: the LCT 3/363 model has a total length equal to 3x5,48=16,44 m.

Dimensions are subject to changes without notice
Technical drawings will be supplied on order

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