COOLING TOWERS

(MCT 25 – 45 – 300 – 400 – 800 – 1200)

MITA cooling technologies

INSTRUCTIONS FOR USAGE AND MAINTENANCE

April 2018 Edition

The preparation and editing of this manual was made by MITA Cooling Technologies S.r.l.

Headquarters :
Via del Benessere 13
I-27010 Siziano (PV)

Tel. +39 0382 67599

Fax. +39 0382 617640

Website http://www.mitacoolingtechnologies.com

E-Mail info@mitact.it

INDEX

1. Introduction Page 3

2. Operation (indications of the theoretical aspects) Page 4

3. Transport and packaging Page 5

4. Description of the equipment and technical data Page 8

5. Layout and installation of the cooling tower Page 12

6. Start-up/Commissioning Page 17

7. Limits of usage Page 18

8. Safety warnings Page 21

9. Maintenance Page 22

10. Accessories Page 28

Information regarding water treatment Page 27

1. Introduction

This manual is intended to be a general guide to the installation, the use and the maintenance of "MCT" series evaporative cooling towers for industrial water cooling.

Prior to performing whatever intervention or activity for the unit, the instructions contained in this manual should be carefully read; any disregard of the same may give rise to problems for which MITA will not accept any responsibility.

For further clarifications please consult exclusively MITA or her closest official local representative.

1.1 Use envisaged

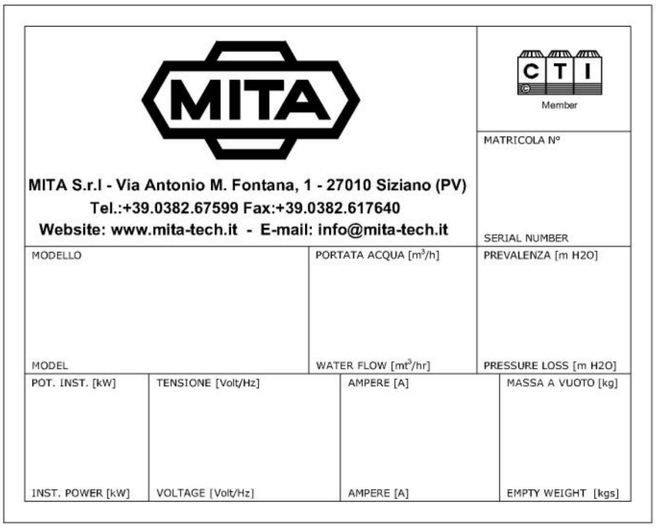
The cooling towers herein described and illustrated are suitable for the cooling of industrial-type water, nonetheless chemically and physically clean; in the case of water containing acid, suspended solids, or at high temperature, please refer to the "SPECIAL VERSIONS" Appendix at the end of this manual.

1.2 Limitations to the usage

All types of usage and application different from those envisaged are prohibited and in any case recommended against, particularly those with pollutants and/or compounds poisonous if released to the atmosphere in solution in the water.

1.3 Identification of the unit

The cooling towers manufactured by MITA are equipped with an identification plate, applied on the outside panel , close to the water make-up connection.
This name-plate carries the technical operating data of the unit, in addition to the year of manufacture and the identifying serial number [Fig. 01].
When requesting replacement parts of after-sales technical assistance, the serial number must be provided to MITA.



- Fig. 01 -

1.4 Documentation supplied with, attached to, the Unit

Every MITA cooling tower is provided with a "DECLARATION OF INCORPORATION" (Directive 2006/42/EC) and complies with the following European directives:
- Directive 2014/30/EU and subsequent modifications;
- Directive 2014/35/EU and subsequent modifications.

2. OPERATION (indications of the theoretical aspects)

2.1 General

An evaporative cooling tower gives rise to the forced evaporation of a small part of the circulating water : this absorbs heat from the remaining water volume, which is thus cooled.

2.2 Quantity of water evaporated

For every kilogramme (or litre) of water evaporated , approx. 540 kcal are drawn off from the remaining water. To determine the quantity of water evaporated one must thus apply the formula:

$$\frac{\text{Quantity of rejected heat [kcal/h]}}{\text{540 [kcal/kg]}} = \text{[Litres/h]}$$

2.3 Minimum outlet temperature obtainable from the cooling tower

Theoretically speaking, the minimum temperature obtainable for the water leaving a cooling tower is that of the wet bulb thermometer reading of the surrounding air.

The cooling temperature effectively attainable at the outlet from the cooling tower is however at least two or three degrees centigrade above that theoretical limit (the wet bulb temperature).

2.4 Wet bulb thermometer temperature

For conceptual simplicity one may affirm that the wet bulb thermometer temperature is the temperature of saturated air which has the same heat (enthalpy) content as that of the surrounding ambient air.

It is measured with a dual thermometer psychrometer, or with electronic instruments and takes into account the ambient temperature and the relative humidity of the zone of installation.
This parameter is fundamental to the correct sizing of an evaporative cooling tower.

3. TRANSPORT AND PACKING

3.1 Packing

Generally speaking, no packaging at all is necessary: if explicitly requested, it can be provided in the form of simple cage-type crates or full-box wooden crate (the latter option only in the case of despatch by sea).

3.2 Transport / Shipping

All MITA towers are easily transportable, following a pre-mounting concept in sections. The dimensions of the various modular segments or, where foreseen, of the accessory modules, are within normal vehicle limits and consequently their transport can be effected on standard lorries.

The tower casing must **always** travel in a vertical position: the unit may only be placed on its side if packed in a cage-type or full-box wooden crate and then **only** if this has been specifically made by MITA.

3.3 Handling / Moving the unit

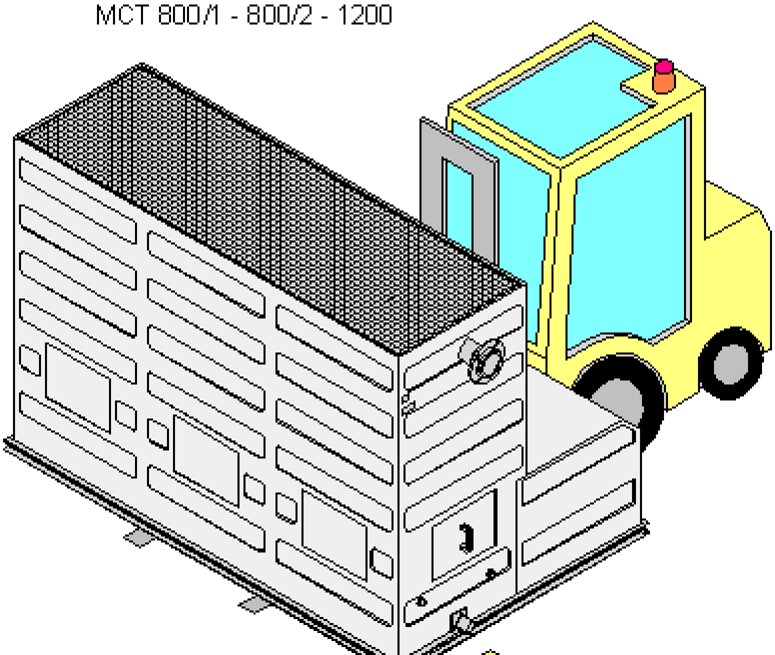
Great care must always be taken during the handling / moving of the cooling tower (loading, unloading and final positioning) and only suitable mechanical means should be used (fork-lift truck with extended forks or mobile crane).

When a normal fork-lift truck with extended forks is employed, the forks must be positioned as shown in Fig.03.

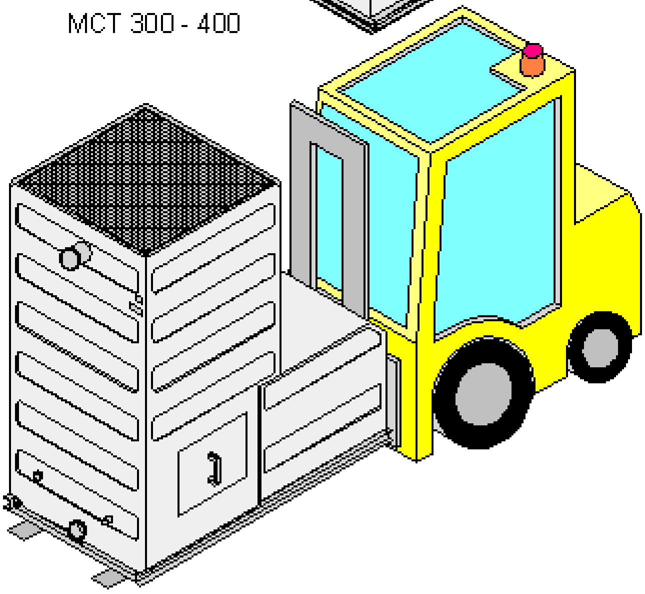
CAUTION !

All the phases of moving, positioning and lifting must be performed by specialized personnel, using devices of appropriate capacity

MCT 800/1 - 800/2 - 1200



MCT 300 - 400



MCT 25 – 45

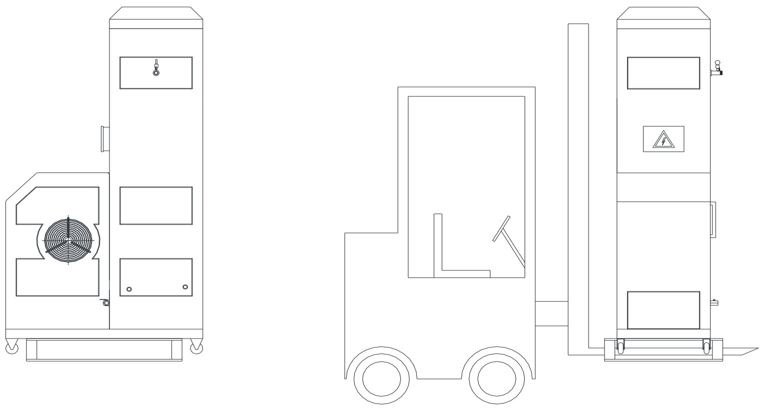


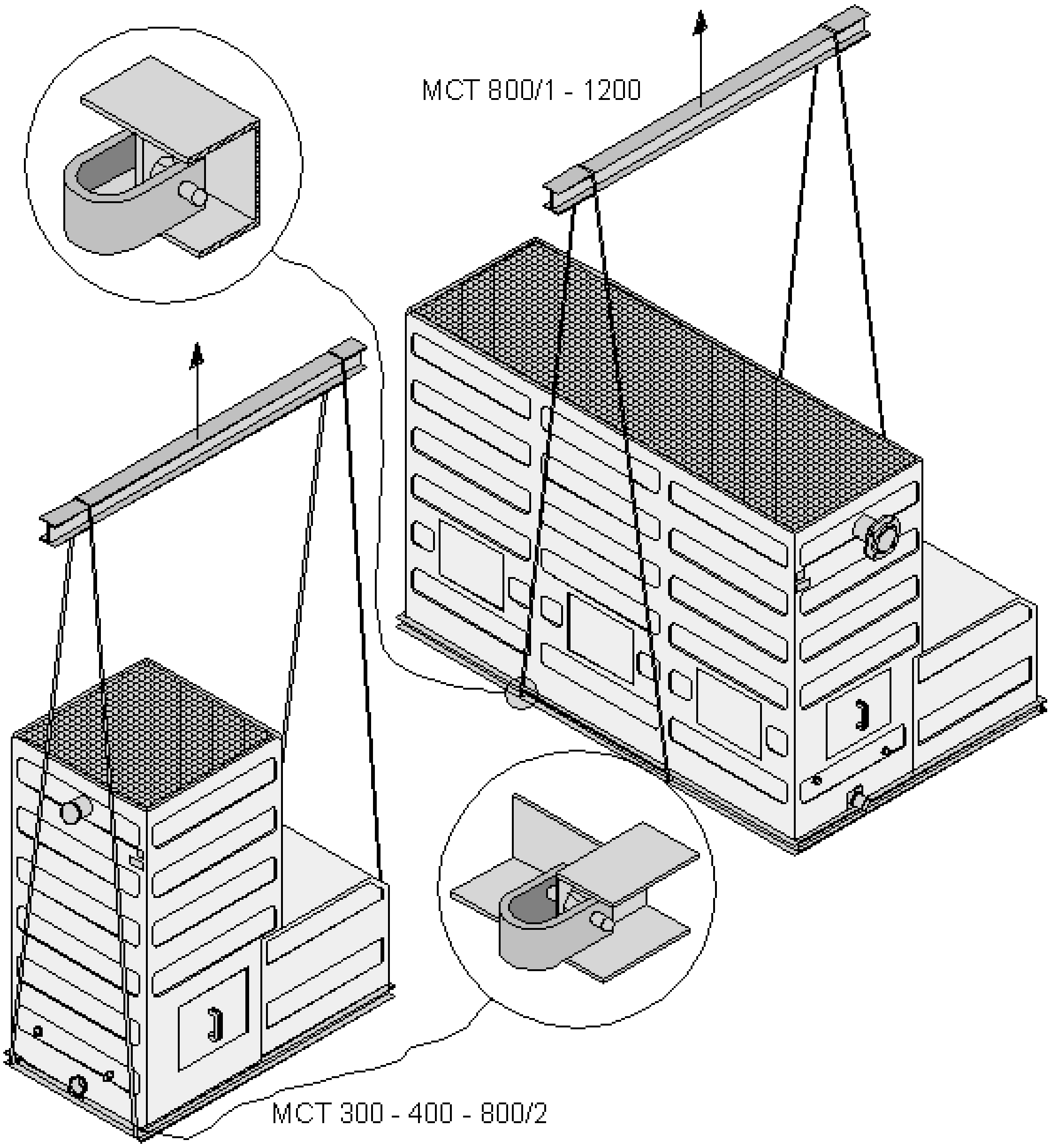
Fig. 03 -

Wherever the necessity may arise, or in the case of the use of a mobile crane, the tower and its components can also be lifted using wide slings (at least 8 cm).

The positions for applying the slings are illustrated in the figures shown below in [Fig. 04].

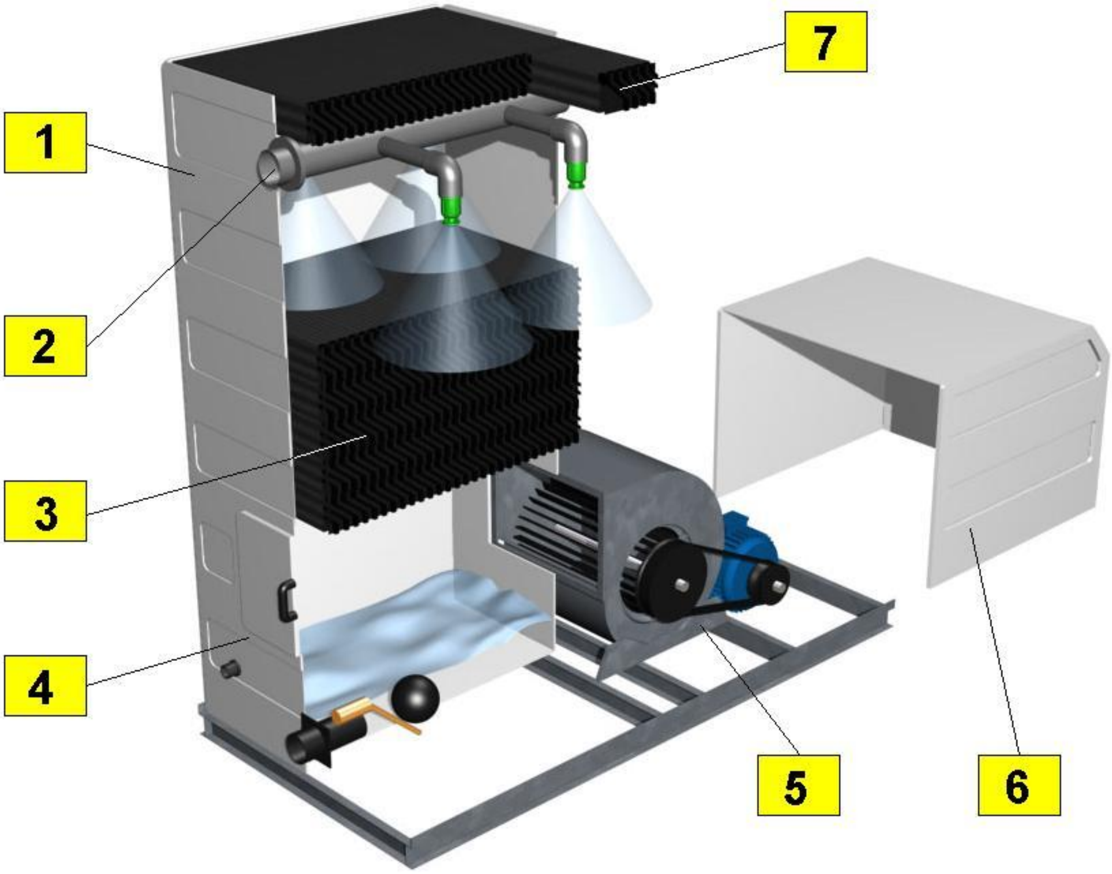
CAUTION !

Never stand beneath suspended loads during lifting operations



- Fig. 04 -

4. DESCRIPTION OF THE EQUIPMENT (UNIT) AND TECHNICAL DATA



Main casing

The main casing structure and the fan cover box of the MCT series cooling towers are entirely manufactured from fibreglass-reinforced polyester resin and are fixed to a metallic containing framework.

In fact the casing and the cover box are produced by lamination on specially prepared moulds, of successive layers of glass fibre matting impregnated with catalysed polyester resin and appear as single-piece elements which are structurally self-supporting. .

Item 1. Casing / Shell

This is the operating part of the cooling tower and contains the fill pack (or heat exchange surface), the drift / droplet eliminators and the distribution system for the water to be cooled.

The casing body also contains the cooled water collection basin (not separable from the upper section of the shell-casing) and the manhole-hatch for partial access to the basin and its cleaning.

In all the MCT towers, the fill pack is supported by reinforced polyester profiles bolted to special guide bars which are fixed to the inside walls of the casing body.

Item 2. Water distribution system

The water to be cooled is introduced into the cooling tower through a distribution system comprising one or two plastic headers, fitted on one side of the tower casing and equipped with a threaded (gas-type) inlet connection (: upon request a flanged connection with the related steel counter-flange can be supplied).

Inside the cooling tower, a series of spray side-braches are connected to the main header, and a spray nozzle is fitted at the extremity of each of the former. These nozzles are injection moulded on a mould belonging to MITA and are of a static and self-cleaning type [Fig. 05].

NOTE: In the case of particularly dirty water it is advisable to fit nozzles with a tangential water inlet connection

STANDARD VERSION

TANGENTIAL VERSION

- Fig. 05

Item 3. Fill Pack (Heat exchange surface)

The fill pack employed in the MCT cooling towers consists of blocks obtained from single vacuum thermo-formed sheets of PVC that are then glued together. These are suitable for use with water at temperatures of max 55°C.
The fill blocks have small air-water channels (12 mm flute) designed for use with water suitably treated both chemically and physically, to optimise contact between the air and the water.

IMPORTANT !

When replacing the fill, it is recommended to use items identical to the original and to avoid differences in the air side pressure drop, which could cause damage to the motor-fan set.

Item 4. Basin

As previously indicated, the basin is located in the lower section of the tower casing and collects the cooled water coming from the heat exchange packing.

The basin is fitted with connections for the cooled water outlet, for the overflow, the make-up water float valve and the bottom drain tap.

If foreseen or requested, it can also be equipped with the following optional accessories:

- Heating element with control thermostat
- Fan ON/OFF thermostat
- Min level cut-out switch

NOTE: if the basin of the tower simply serves as a drainage area and remains almost always empty, i.e. if there is a remote sump beneath the tower, the float-valve for the make-up of the evaporated water should be located in the remote sump itself.

Item 5. Motor-fan assembly (for MCT 300-400-800-1200 models)

The MCT series cooling towers have a centrifugal fan, belt-driven by the electric fan motor.

The electric motors are designed for operation with their shafts horizontal (construction form B3), in totally closed and sealed execution (IP 55 protection), class F / B insulation, possibility of multi-voltage and multi-frequency electrical supply (220/240 – 3807415 volt, 50 – 60 Hz).

Unified series according to UNEL-MEC, the **bearings** are **maintenance-free and greasing-free**.
The motor-fan set is fitted on a robust steel frame, hot-dip galvanised after fabrication, which accommodates also the main casing of the tower and the fan cover box.

The electric motor must be controlled and protected by a remote motor-overload protection switch, which can also allow the control of the fan by means of an ON/OFF thermostat, as a function of the cold water leaving temperature.

Item 5. Motor-fan assembly (for MCT 25-45 models)

The MCT series cooling towers have a centrifugal fan directly coupled with the motor.

The electric motor must be controlled and protected by a remote motor-overload protection switch, which can also allow the control of the fan by means of an ON/OFF thermostat, as a function of the cold water leaving temperature.

Item 6. Fan cover box

This has the role of protecting the motor-fan set against the elements and preventing accidental contact with its rotating parts.

The box is provided with air intake vent fitted with AISI 304 stainless steel protection grid.

The box can easily be removed for access to the motor-fan assembly by sliding it along its bottom frame.

Item 7. Drift / droplet eliminator

The drift /droplet eliminator consists of panels, manufactured in a manner similar to that of the fill pack, but of a shape and size designed to obtain the max separation and elimination of the droplets of water from the air stream created by the fan.

Manometer

This is supplied loose as a separate item and must be installed near the hot water flange in the tower. This has the function to check the pressure of the water entering the tower.

- Fig. 06 -

The value shown by the needle must approximately approach to the head pressure, in water column meters, indicated on the identification plate of the cooling tower and in the order confirmation.

If ever the needles oscillates strongly or in jerks, one must check the correct operation of the hot water supply pump to the cooling tower, or that there is no air in the piping, caused by too low a water level in the basin (in this latter instance, check that the supply of make-up water has not been interrupted and that the float ball is in a position such that adequate filling of the basin is allowed).

NOTE: the water flowrate evaluated by means of the feed / supply pressure is correct to an accuracy of ± 5%. To obtain an exact measurement one must install an appropriate calibrated flange meter or a volumetric metering device.

5. LAYOUT AND INSTALLATION OF THE COOLING TOWER

5.1 Parameters and general considerations

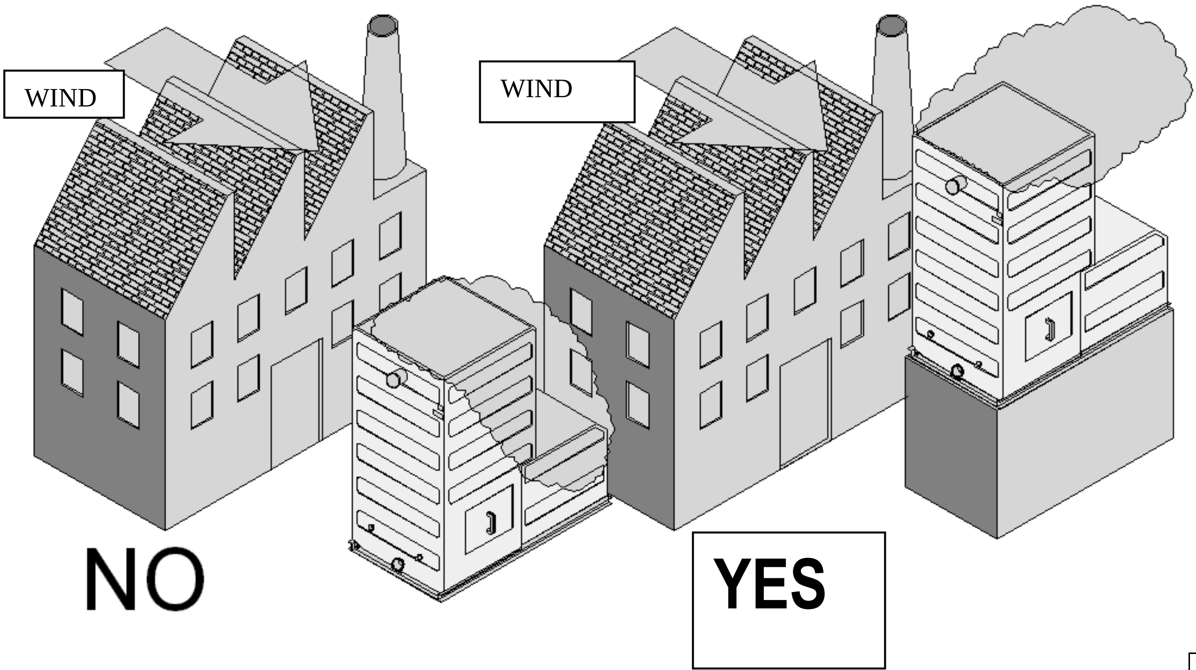
Correct operation of the evaporative cooling tower is also dependent upon the observance of several rules of a general nature but of fundamental importance, to which it is advisable to adhere already in the phase of choice of the place for installation of the equipment.

In summary, these rules are the following:

5.1.1 Layout

- **The cooling tower must always be installed outside**, so far as possible in a well-aerated position and such as to respect a minimum distance (at least equivalent to the size of an air intake) from walls and buildings. Whether or not it is placed in a very sunny spot has no influence upon the thermal performance of the unit. Only in special cases and respecting very precise indications that can be provided by MITA's technical dept.., can one consider the possibility of a different form of installation.

- **avoid totally and absolutely making roofing, screening, ductwork** or other hindrance to the correct and free circulation of air to, from and within the tower, if not previously agreed with MITA's technical department (e.g. air intake & discharge sound attenuators). Moreover be particularly careful about the possible presence of prevailing winds and that eventual "down-wind" situations cannot give rise to air recirculation on the tower [Fig. 09].



- Fig. 09 -

- **The cooling tower must be installed as far as is possible away from zones usually occupied by persons, from open windows or from air-intakes to buildings.**

- **avoid siting the tower under a roof or covering**: the resultant impedance to the free discharge of the outlet air, which is thus created, may be cause of recirculation of that same air which, having a saturation humidity, penalizes in a significant manner the tower's thermal performance.

- **avoid siting the tower under or near to trees**: above all in the Autumn, the falling leaves might be drawn in by the fans, finishing in the hydraulic circuit and creating serious problems for the pumps and in the cooling circuit in general.

- In the case of **installations in small courtyards or in restricted spaces**, be particularly careful about the orientation of the tower and about the remaining space available around it both for unrestricted airflow, and for allowing installation of the piping and eventual maintenance operations.

IMPORTANT !

The bottom of the basin is NOT self-supporting and must always rest upon a continuous flat surface; in the case of a raised support, one must foresee an adequately sized metallic structure, consisting of a perimeter framework with parallel traversal profiles (placed at not more than 300 mm from each other), or incorporating metallic or fibreglass grilles.

5.2 Installation

5.2.1 General notes

The cooling tower must **always be installed on a flat**, **perfectly horizontal surface.**

It should be remembered that :

. if the fan does not rotate about a horizontal axis, abnormal accelerations are created that become loads upon the drive system in general and on the fan bearings in particular, with the possibility that they will be irremediably damaged.

Where the pump suction is directly from the cold water outlet connection, the level of the bottom of the basin on its support must always be at least 20 cm higher than the centre line of the suction connection of the pump itself (an available "water head" situation). Otherwise vortices and air bubbles can form, causing pump cavitation.

So far as the fixing of the cooling tower to the round is concerned, even though the tower's own weight is sufficient to impede any movement, anchorage can be made by tie-bolts or fixing pins to be inserted through the holes located in the metal base frame.

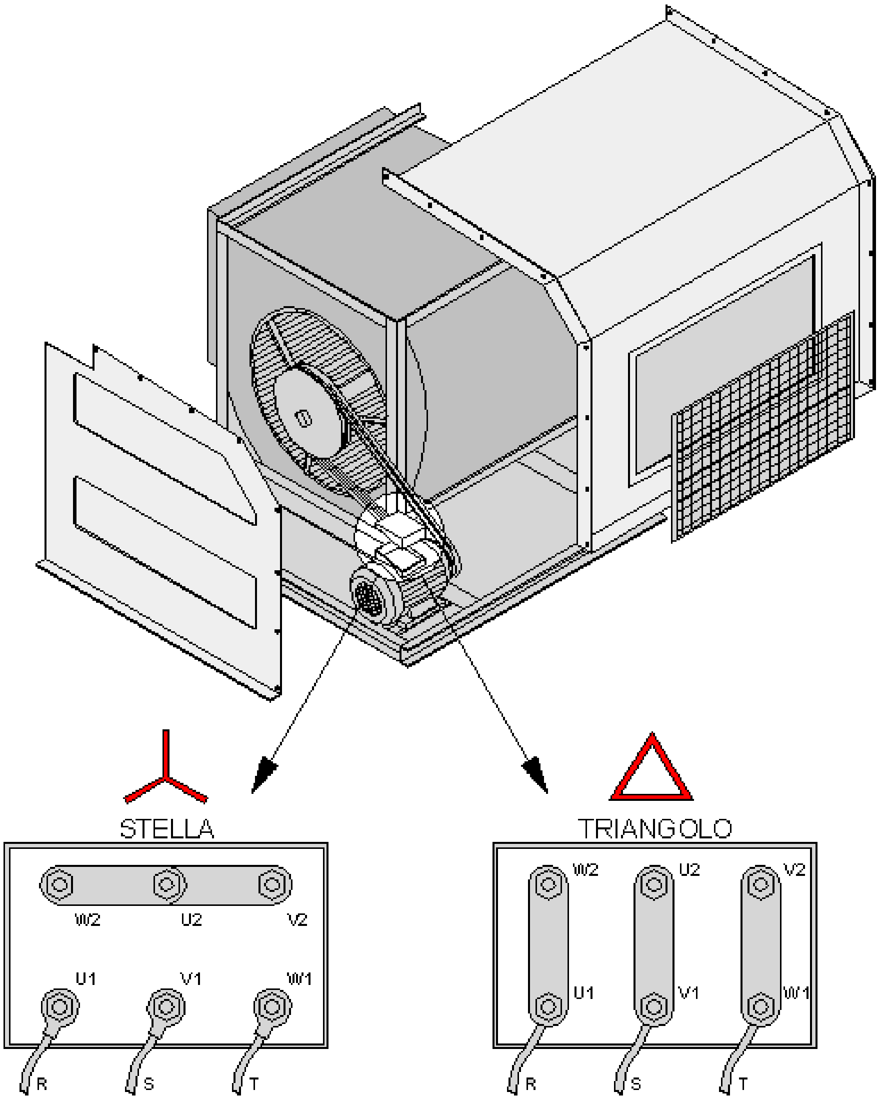
5.2.2 Electric wiring

All the MCT series cooling towers are equipped with electric motors usually ready for connection to a 3-phase electrical supply.

IMPORTANT !

All electric wiring must be performed by specialist personnel, also allowing for the earthing of the motor.

The configuration of the platelets inside the terminal box on the motor must thus be one of the two shown below [Fig. 10]:

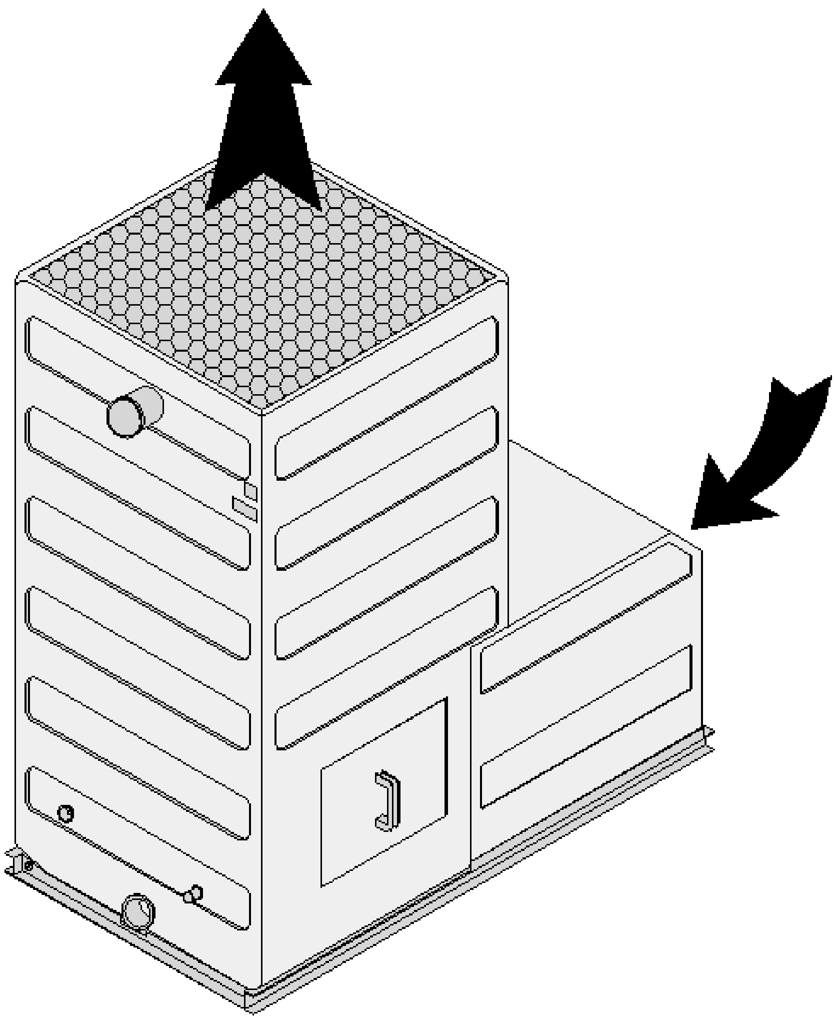


- Fig. 10 -

STELLA = STAR // TRIANGOLO = DELTA

NOTE: However always check the type of connection to be effected in accordance with the wiring scheme provided by the motor manufacturer on the data plate (for MCT 300-400-800-1200 models) or inside the terminal box (for MCT 25-45 models).

Once the electrical wiring has been completed, give an impulse of electric current to the motor and check that the direction of rotation of the centrifugal fan is such that air is indeed drawn in from the lower part of the cooling tower (intake grille on the cover-box) and expelled from the top.
If this is not the case, invert the rotation direction by simply swapping over the positions at the terminals of the motor of two of the three phases of the power supply line, having previously cut-off the electrical supply up-line [Fig. 11].



- Fig. 11

NOTE: all fans are checked and tested at the factory, nonetheless before making electric power connection to the motor it is advisable to check that the fan wheel rotates freely inside its metal cowling, by turning it by hand for several complete turns.

Close the junction box, taking great care to ensure that the gasket placed between the lid and the box itself is correctly positioned and that the cable entries are completely tightened.

5.2.3 Hydraulic connections / piping

Every evaporative cooling tower is fitted with a series of hydraulic connections, each of which has its specific function.

One or more threaded (gas) connections, depending upon the model, are located on the upper part of the main casing : these are at the entry to the water distribution header inside the tower and to these must be connected the piping of the hot water supply from the installation to be cooled.
One may find that the diameter of the hot water inlet connection on the cooling tower is greater than the diameter of the hot water return line from the plant: the reason for this derives from both the fact that the diameter of the water distribution piping is calculated and designed, for each model, for the maximum admissible flowrate, and in order to allow a more homogeneous water distribution inside the header.

Precautions to be taken:

- **It is good practice to insert an expansion joint or a rubber anti-vibration connector between the inlet water inlet connection and the supply pipe from the installation.**
- **do not allow the water supply line from the installation (generally, made from steel and full of water) to impose a load upon the flanged connection of the cooling tower, but rather provide a support framework for that purpose.**

The cold water return connections, which are usually connected to the pump which sends water to the equipment to be cooled, are located in the lower, basin section of the tower; if the installation is provided with a remote sump placed at a lower level than that of the tower, the return water connections can also drain freely by gravity into the sump below, but it may be necessary to replace the original connection with another of greater diameter (or alternatively, add a second connection).

In order to avoid water-leakage from the water outlet connection, it is recommended that teflon tape be employed on the thread

In the basin are also located:

- the overflow connection, which must be connected to the drain piping to the sewer.

- The connection associated with the float-valve, for the automatic make-up of the evaporated and the bleed-off water.

- The bottom drain, which permits total of partial emptying of the basin, for eventual cleaning or repairs.

All the above connections are gas-type threaded (male thread); on request they can be supplied flanged with the related counter-flange in steel.

5.2.4 Treatment of the make-up water (SEE ATTACHED INFORMATION REGARDING WATER TREATMENT)

6. START-UP / COMMISSIONING

6.1 Preliminary checks

Prior to starting-up the cooling plant, previously filled with water, perform the following operations and checks:

1) Operate the fan and check that it rotates in the sense such that the air enters via the intake opening in the fan cover box and leaves from the top of the cooling tower.

If this does not happen, stop the fan, then change the direction of rotation of the motor, swapping over the positions of two of the three phases (see page 19).

The direction of rotation of the fans should in any case be checked every time that repairs are made to, or maintenance is performed on the electric motors and their control system.

2) Operate the water circulating pump and check:

- the water-tightness of the threaded and any flanged connection joints and of the related gaskets

- the head pressure, in meters of water gauge, indicated by the glycerine hydrometer. It should be borne in mind that it is necessary that the value read does correspond to that indicated on the identification plate that is to be found on the side of the unit: otherwise, it means that the water flowrate of the circuit is different from the design value for which the cooling tower was sized

If the water flowrate is too high (**inlet head pressure to the cooling tower greater than the nameplate value**), the following situations can occur:

- temperature range over the cooling tower lower than the nominal design value and the temperatures higher (i.e. a cold water temperature greater than the design value envisaged)

- a poor water distribution inside the cooling tower caused by an excessive opening of the cone of water exiting from the spray nozzles: this provokes an anomalous wetting of the inside walls of the cooling tower with a certain quantity of water which reaches the collecting basin without having been cooled.

On the contrary, if the water flowrate is too low (**head pressure at the cooling tower inlet lower than the nameplate value**), the following situations can arise:

- temperature range over the cooling tower greater than the nominal design value and the temperatures higher (i.e. a cold water temperature greater than the design value envisaged)

- a poor water distribution inside the cooling tower caused by an insufficient opening of the cone of water exiting from the spray nozzles: this provokes a poor usage of the heat exchange surface of the fill pack, thereby limiting its effective efficiency.

3) Operate **<u>simultaneously</u>** the fan and the water recirculating pump, checking carefully the absorbed currents of the related motors and ensure that the values measured do not exceed those indicated on their respective data plates.

If there are differences or anomalies, check that the voltage and frequency values are the same as those for which the evaporative cooling tower has been designed: if those values prove to be correct, then the cause of the anomaly must be sought elsewhere.

7. LIMITS OF USAGE

7.1 Maximum allowable temperature in MCT (standard series) cooling towers

The maximum admissible water inlet temperature for the cooling tower depends upon the nature of the materials comprising its water-contact components.

In their standard execution, MCT cooling towers can accept inlet water at a maximum temperature of 55 - 60°C.

In cases in which higher temperature water must be fed to the tower, a casing, fill pack and distribution pipe manufactured from special materials must be employed. The maximum operating temperature is thereby raised to 85 - 90°C.

Whenever one wishes to avoid the adoption of special materials, one can obtain the same result by mixing, in an auxiliary tank/sump, the hot water to be cooled and water cooled by the tower in order to bring the temperature of the mix under the 55 / 60°C limit.

For further information regarding the special versions for high temperature or particular solutions related to execution of the installation, please contact MITA's technical department.

7.2 Make-up with river water

When river water is employed for cooling tower make-up, apart from the problems of acidity and hardness normally associated with make-up water of any origin, one must evaluate with great care the possible presence of suspended solids, which could even be of significant size, as well as that of slime, sand and clay.

In this case, it is useful to have available a suitable filtration system, preceded upstream by net- screens to stop the largest foreign bodies (from entering the system).

7.3 Make-up with slightly salty water

Recalling that the fibreglass parts do not suffer at all from the presence of salts in the water, some difficulty can on the other hand arise for the metallic parts in as much as the salty water (by which is intended water with traces of chlorides) gives rise to chemical action, particularly on galvanised steel components, when there are faults, even if only minimal, in the protective zinc layer (base-frame of the cooling tower and the centrifugal fan).
Therefore, in this particular situation, it is advisable to have a preference for the cooling tower in the INOX (sst) version, i.e. with the base-frame executed in stainless steel AISI 304 and the fan with adequate corrosion protection (coating).
NOTE: there are limits to the concentration of chlorides that various stainless steel grades can resist.

7.4 Winter operation

In areas in which the ambient winter temperature descends below 0°C, there is a possibility of ice formation in or upon the tower components and in the immediately surrounding area.

The equipment and the zones most subject to freezing and to ice formation are:

- **the water collecting basins**
- **the water supply and return pipes, as well as those of the auxiliary circuits**
- **occasionally, the ground area surrounding the cooling tower**

Generally speaking, when the cooling tower is in normal operation also during the winter season, no danger of freezing exists. It is however possible that, with outside temperatures below -2°C / -3°C, ice formation occurs even in the case of very brief shut-downs.

7.4.1 Ice formation in the basins

Ice formation starts from the surface of the water, then the process extends to the entire water mass contained in the basin; progressively as the phenomenon proceeds the volume of ice increases, its speed of formation diminishes.
To remedy this problem one can install one or more electric heaters, of adequately sized electric power, and controlled by an appropriate regulating thermostat, which assure a water temperature between +3°C and 5°C in the whole basin or, in the case of very big basins (those of the larger models), in an area of them sufficiently large to ensure that remains liquid at least the volume of water necessary to start-up the system.

One can also resort to an auxiliary, remote sump, situated in a closed space or underground, in which the water cooled by the tower can drain freely in such a manner that the tower collecting basin remains always empty.

NOTE: the thermostat supplied together with the electrical resistance heaters acts exclusively as a function of the basin water temperature, and not on the basis of the heat produced by the heater itself.
Hence, in the case of absence of water, the heater being still operative could be irremediably damaged: it is thus recommended to foresee a low-level cut-out switch, as a protection of the electrical resistance heater in the eventuality that it is not covered by water.

7.4.2 Ice formation in the circuit piping

The water in the piping forms ice starting from the layers in contact with the tube wall and the phenomenon slows progressively as the freezing proceeds towards the centre.
The water, transforming itself into ice inside the pipes, increases in volume by about 8%, nearly always causing the splitting open of the latter.

As a remedy to this eventuality, one can execute the circuit in such a manner that, at plant shut-down, the water drains into a remote (auxiliary) sump located inside or below ground level, or one can adopt the installation of heat-tracing cable wound around the pipework and its subsequent protection with shells of insulating material.

7.4.3 Ice formation around the cooling tower

Those few water droplets which are entrained by the current of air discharged by the fan and the effect of the condensation of the water vapour dissolved in the air leaving the cooling tower at very low outside temperatures, falling back into the area surrounding the cooling tower, can cause the formation of sheets of ice.

Such ice formation, which clearly does not have any influence upon correct operation of the cooling tower, constitutes a hazard for whoever must, for whatever reason, approach the cooling tower and renders maintenance or repair work difficult.
If there is a need move about in the zones where icing is present, sand and sodium or calcium chloride should be spread, to produce at least temporary melting of the ice.

7.5 Operation in dusty and polluted environments

During its operation, the fan of an evaporative cooling tower draws in significant quantities of air (between several thousand and several hundred thousand m^3/h, according to the model): this air, in the phase of close contact with the water to be cooled, is "washed" of the physical and chemical impurities that it contained which, in consequence, accumulate in the water itself.

The solid particles, generally speaking, do not have any chemical activity and the pollution derived from them is only physical: to remediate for this, one can opt for an adequate water filtration system upstream of the pump suction, along with a choice of a fill pack with a configuration suitable for operation in the presence of cooling water with suspended solids (for any needs for clarifications on this subject, please contact MITA's technicacl department).

Gaseous or liquid compounds, once dissolved in the water, are, on the contrary, significantly chemically active and can generate both corrosion phenomena, and the formation of solid agglomerates with other foreign bodies contained in the air or in the water.

Considering that the MITA evaporative cooling tower, being manufactured totally from materials inert to corrosion, eliminates the problem at the root of the majority of cases, it is only in particular situations (eventual presence of acid vapours in the surrounding air) that one might opt for the execution of the tower's metallic components in stainless steel.

8. SAFETY WARININGS

8.1 Fan cover box

Every fibreglass fan cover box is designed and built to withstand modest and occasional static loads (e.g. that of snow).

IMPORTANT !

This cover box is, on the other hand, not intended to withstand concentrated loads due to people standing or resting on it, both for structural reasons and because of its polished surface which, in particularly wet conditions, renders the surface extremely slippery.

8.2 Motor-fan assembly

This is the only moving part of the evaporative cooling tower and, as such, requires the respect of several elementary safety norms.

In particular it is recommended:

- to always cut-off the power supply to the motor before carrying out any work on the fan (it is good practice to install a key operated circuit breaker near the fan);
- not to use the motor-fan set if, for any reason, the protective covering box has been removed. If this is unavoidable, avoid absolutely working near the drive system or the blades of the fan wheel.
- Not to modify or replace for any reason the pulleys of the drive system: that could cause absorbed electric power beyond data plate values, vibrations due to imperfect alignment of the pulleys, breakage of the motor or fan bearings (for MCT 300-400-800-1200 models).

9. MAINTENANCE

WARNING !

All maintenance work must be performed by specialist personnel or directly by the manufacturer, always following safety-at-work procedures**.**

9.1 Maintenance of the casing (shell)

The casing as a whole does not necessitate any maintenance action(s).

Any eventual cleaning operations can be effected as simple washing with soap or detergent and water.

It is however recommended to avoid the use of solvents.

NOTE: the repair of any eventual breakage of the fibreglass components due to impact or mechanical causes is to be performed with glass-fibre mat and polyester resin that are available from MITA in appropriate sets (repair KIT).

For the usage of this kit-box and for any repair itself, the following instructions should be adhered to:

a) carefully dry the inside part of the cooling tower, in the area in which the repair must be performed. Remember that repair by means of material addition must always be effected from the inside, i.e. acting upon the rough surface of the cooling tower (and not on the smooth external part)

b) Fully align the edges of the breakage. Eventually they can be fixed in place with copper wire so that they cannot change position in the course of the repair work.

c) abrade with sandpaper the zone around the breakage, on to which the glass-fibre mat will be laid. If the breakage has occurred in the basin, since its internal surface is protected by a hydro-repellent, paraffin-containing gel-coat, the sanding must be continued until that protection has been eliminated and the underlying resin appears.

d) cut the glass-fibre mat into a form adapt for the repair.
The mat must surpass each edge of the breakage by 7 - 10 cm according to the size and nature of the breakage itself.

e) catalyse the polyester resin, mixing component 1 (resin) with component 2 (catalyst) in the following proportions:

component 1 (resin) : between 98 and 96% (by weight or volume)

-component 2 (catalyst) : between 2 and 4% (by weight or volume)
The mix must be prepared not more than 10 minutes prior to use; it is moreover advisable not to catalyse all the resin in one go, but rather to proceed in two or three stages in succession (possibly making a preliminary test with a small quantity of resin and catalyst)

place the glass-fibre matting, prepared previously, in such a manner that it covers and extends beyond the crack-seams of the breakage and apply the catalysed resin using a roller, taking care to ensure that the glass-fibres mats are completely and uniformly impregnated. Repeat this operation two or three times, without waiting for the underlying layers to dry.

g) the sealing of the repair will already be sufficient after about 8 - 10 hours if the ambient temperature exceeds 15°C, otherwise after 15 - 24 hours.

The complete catalysing of the resin occurs within 48 - 72 hours: after that lapse of time the cooling tower can be put back into service.

9.2 Maintenance of the motor-fan set (for MCT 300-400-800-1200 models)

As better illustrated above, the centrifugal motor-fan assembly does not necessitate particular maintenance action(s) but rather a few simple and elementary regular checks.

The electric motor, the sole moving part which actions the fan, is in fact foreseen for continuous operation and is equipped with completely water-tight and self-lubricating bearings.

Nonetheless it is advisable to make a periodic inspection of the motor-fan set, so that it is possible to identify in good time eventual operating anomalies.

Amongst these, are indicated below those most probable and their related causes:

- vibrations of the whole assembly (breakage of one or more blades of the fan wheel, loose belts, damaged motor or fan bearing)
- increased sound level (damaged motor or fan bearing, worn belts)
- absorbed current greater than the data-plate value (damaged bearing, obstruction on the air intake openings or over the air discharge, fill pack or droplet eliminators occluded)

9.3 Maintenance of the fill pack

The fill pack (or heat exchange surface) does not require any particular maintenance, if not that deriving from a proper treatment of the make-up water.

It is however good practice to effect periodic checks of its state, by means of visual inspection to be made via the access hatch or from above by removing some drift eliminator panels in order to verify: dirt accumulation, presence of algae and biofilm, presence of scaling,.

In cases in which the air/water channels become occluded , the thermal performance of the cooling tower may be drastically reduced, resulting in higher operating temperatures (water inlet and outlet temperatures) and an increase in the current absorbed by the electric motor, with the possibility of its irremediable damage.

One should also bear in mind that deposits in the fill pack, of whatever nature they may be, increase out of all proportion the weight of the fill itself (even to 10 times the original), and can damage, even very seriously, the related support.

Hence, when one or more of the above situations manifest themselves, it is recommended to effect a timely shut-down of the installation and to replace immediately the fill pack.

9.4 Maintenance of the drift / droplet eliminator panels

As in the case of the fill material, this component also does not require particular maintenance activity.

It is simply advisable to make a periodic check upon the state of cleanliness of the panels and that these are in an orderly manner in their correct location and that there are no gaps between one panel and another.

9.5 Maintenance of the water distribution system

The system is virtually maintenance free, since it is static (no moving parts) and it is 100% in plastic (PVC main header and side branches, self-cleaning polypropylene spray nozzles).

9.6 Maintenance of the float-valve

The absolute efficiency of this device is of fundamental importance for the correct operation of the cooling plant.
The water which evaporates is in fact automatically replaced via the float-valve, which also determines the water level in the basin of the tower.

Hence ensure that:

- the float valve opens before the level of water in the basin drops below the level of the pump suction connection, to prevent this from drawing in air (check when both the tower and the pump are running);
- the float valve closes before the water reaches the level of the overflow and, above all, that it closes when the tower and pump are shut-off, in order to avoid wastage of water;
- the moving parts in the valve are greased regularly

NOTE: any eventual adjustments should be effected by moving the float-ball along the lever arm of the valve, until it is in a position in which both of the above-indicated conditions are satisfied.

9.7 Maintenance of the bleed-off valve / tap

Ensure that the bleed-off tap discharges freely and that there are no obstructions, even partial, that could limit its operativity.

If the tap were to become occluded, it can be readily unscrewed from the three-way connection that holds it and disassembled into its constituent parts for cleaning.

If the occlusion of the tap was caused by deposition of scale, it is possible to effect washing with suitable products, readily obtainable on the market, which dissolve the scale.
Given the proximity of the glycerine hydrometer and the bleed tap, it is probable that if the latter is blocked then the orifice of the manometer will also be: it is thus wise that when the tap is dismounted the hydrometer should also be verified and cleaned as appropriate.

SUMMARY TABLE OF MAINTENANCE ACTIONS AND OF PERIODIC CHECKS

TYPE OF ACTION	REFERENCE PARAGRAPH	FIRST MONTH	EVERY 6 MONTHS	ONCE A YEAR
Maintenance of the casing	***9.1***	●		●
Maintenance of the motor-fan set	***9.2***	●	●	
Maintenance of the fill pack	***9.3***	●	●	
Maintenance of the drift / droplet eliminator panels	***9.4***	●	●	
Maintenance of the water distribution system	***9.5***	●	●	
Maintenance of the float-valve	***9.6***	●		●
Maintenance of the bleed-off tap	***9.7***	●		●

10. OPTIONAL ACCESSORIES

For every evaporative cooling tower model various accessories and construction variants are available which can be supplied together with the tower itself, and for some of them, even at a later stage as retrofit.

The most common of these, and the situations in which their use is recommended are as follows:

ELECTRICAL RESISTANCE HEATER ELEMENT	(of adequate power rating for the basin capacity), it is supplied complete with the regulating thermostat. Serves to avoid ice formation in the basin during eventual plant shut-downs in the cold/winter season.
LOW LEVEL CUT-OUT SWITCH	In the basin. Its purpose is to avoid that, if ever the supply of make-up water is interrupted and the water level in the basin descends, the pump draws in air going into cavitation or that, if the electric heating elements are installed, these can operate without water being present in the basin. It can also operate in an alarm function, providing a signal of anomalies in the make-up system.
FAN ON-OFF THERMOSTAT	Its purpose is to stop the tower fan in the case of excessive decrease in the temperature of the basin water, owing to reduced heat load or in cold weather.
TWO SPEED MOTOR	It serves the purpose of modulating the cooling capacity of the evaporative cooling tower as a function of the heat load in a given moment (if variable) or in the colder seasons. It is controlled by thermostat located in the cold water collecting basin, on the basis of the temperature of the latter.
ELECTRIC CONTROL PANEL	for control and regulation. In the most simple version, it serves exclusively to control and regulate the correct operation of the fan motor. Upon request from the Customer, controls and regulatory devices related to other components of the cooling plant (e.g. recirculating pump, electric resistance heater, thermostat etc.) can be included.
FILTER	On the water outlet connection and in AISI 304 stainless steel, it is of an anti-cavitation type. Its purpose is to capture possible larger foreign bodies (rags, sheets of newspaper, birds, etc.) that might accidentally finish up in the water collecting basin.
FLANGED DRAIN (OUTLET) CONNECTION	In place of the usual male thread drain (outlet) connection, it provides a flanged connection, instead of the usual tube-joint, to the rest of the installation. It involves the construction of a plinth or a framework which raises the cooling tower a few centimetres so that there is no interference between the bottom of the flange and the ground.
COUNTER-FLANGE	In steel, flat type. It is used for connecting up with inlet water flange (supplied as a standard), and with the outlet connection flange (if the latter is supplied in the flanged version).

MANAGEMENT OF WATER IN AN EVAPORATIVE COOLING TOWER

1. Basic chemical parameters

1.1 Calcium hardness

Calcium hardness expresses the amount of calcium dissolved in water, and is expressed in parts per million of calcium carbonate (ppm $CaCO_3$), milligrams of calcium carbonate per litre (mg/l $CaCO_3$) or in French degrees (°F; 1 °F = 10 ppm $CaCO_3$ = 10 mg/l ppm $CaCO_3$).

Waters with very low values of calcium hardness (softened, osmotized, demineralized water) are aggressive to metals and in particular for galvanized steel.

Waters with high values of calcium hardness (commonly called "hard") have a high tendency to form scale deposits of calcium carbonate, mainly on the heat exchange surfaces.

NOTE: concerning water quality it is frequent to meet with the total hardness parameter, which expresses the amount of calcium and magnesium dissolved in water. Since magnesium in water at temperatures below 60°C does not actually contribute to the tendency of water to form scale deposits and the ratio between calcium and magnesium dissolved in water is not a constant (in average it varies from 9:1 to 3:1) using the total hardness value instead of the calcium hardness value for the tower water management introduces an imprecision in the calculations that can be very high.

1.2 M or total alkalinity

The M or total alkalinity expresses the amount of carbonate ions, bicarbonate and hydroxide present in water, and is expressed in parts per million of calcium carbonate (ppm $CaCO_3$) or milligrams per litre of calcium carbonate (mg/l $CaCO_3$; 1 ppm $CaCO_3$ = 1 mg/l $CaCO_3$).

Waters with high M alkalinity value promotes the formation of scale deposits (mainly calcium carbonate) mainly on the heat exchange surfaces; they can also be aggressive to galvanized steel.

1.3 PH

PH is a measure of the acidity (or its opposite, basicity) of an aqueous solution. It can vary from 0 to 14: strongly acidic solutions have a pH close to 0, strongly basic solutions have a pH values close to 14, while neutral solutions have a pH close to the value of 7.

PH of a water tower can be generally correlated to the M alkalinity value and as the latter increases also the pH value increases, it therefore follows that the higher is the pH of a tower water, the higher will be its tendency to form scale deposits.

The pH value also influences significantly the tendency of water to attack the surface of galvanized steel that will corrode rapidly to pH values below 6.5 and above 9.

1.4 Conductivity

The conductivity of water expresses the tendency of this to be crossed by the stream and is an indirect measure of its salt content.

In the management of cooling towers water, conductivity is of particular importance because it is the chemical parameter used for automatic control of the purges carried out using instruments that are capable to continuously determine the value (conductivity meters).

1.5 Microbiological contamination

The level of microbiological contamination of water is the amount of microbial species that are present in it. The typical microbiological contaminants found in tower water are bacteria (mainly aerobic), fungi and algae.

Microorganisms can be introduced into a cooling system through the make-up water, the air used for cooling or, in some cases, through pollution of process fluids. They grow and reproduce metabolizing organic matter in the water or deposited on the plant surfaces.

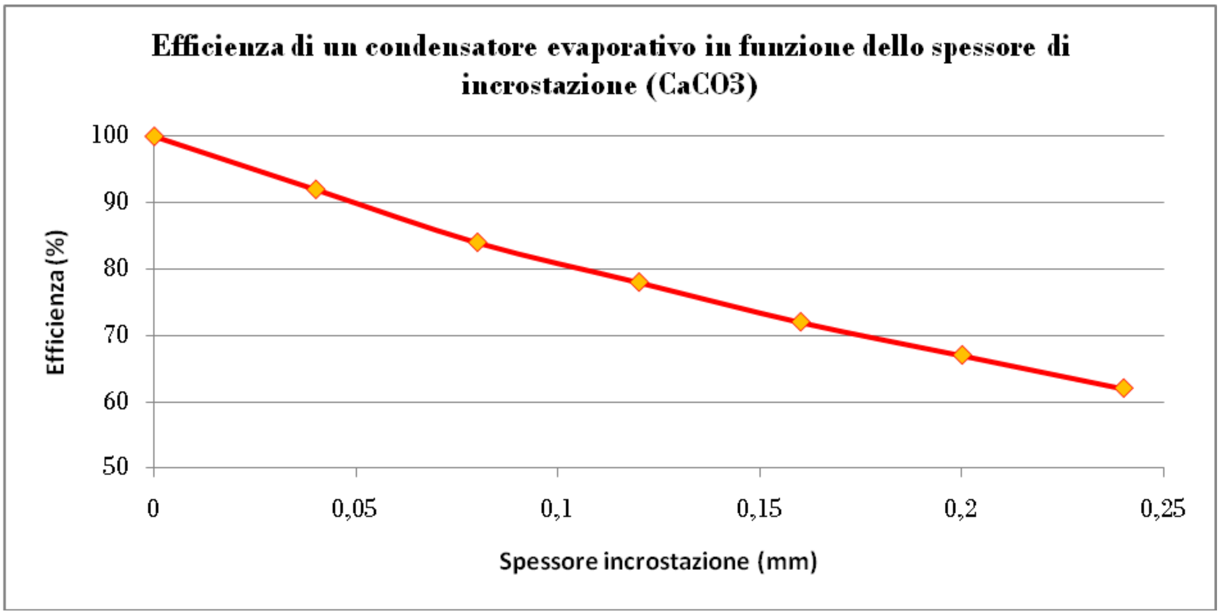
There is not a simple, accurate and reliable method to determine the total level of microbiological contamination of water; by convention therefore we are limited to determining the level of total aerobic bacteria contamination (expressed in CFU/ml) assuming that the algae and fungi contamination is related to this.

2. Inconveniences caused by water in circuits with cooling towers

2.1 Scale deposits

The most common inconvenience found in a cooling circuit with evaporative towers is the formation of scale deposits, mostly composed of calcium carbonate.

Calcium carbonate acts as an excellent thermal insulator: it follows that the presence of scale deposits even of small thickness always causes a drastic decrease in overall plant yield.



Efficiency of an evaporative condenser according to the scale deposit thickness (CaC03)
Efficiency(%)
Scale deposit thickness (mm)

2.2 Corrosion of galvanized steel

Galvanized steel is, in normal conditions, a material particularly resistant to corrosion; this resistance to corrosion is not an intrinsic feature, but is achieved when a compact zinc carbonate adhering layer is formed on its surface.

Galvanized steel may be subject to corrosion when the layer of carbonate has not yet formed (therefore in the first weeks of operation of the plant) or has been removed (for example due to a chemical washing) or when recirculating water has characteristics that can deteriorate it (high or low pH, very low calcium hardness, a high concentration of chlorides and / or free chlorine, etc..)

The corrosion of galvanized steel is manifested by the formation of white/gray material build-up, that can be waxy-looking or as flakes, on the surface of the metal (white rust); this material can be confused with calcium carbonate.

2.3 Disadvantages caused by microbiological contamination

When the microbiological contamination value of water in a plant is high it can rise to an accumulation of gelatinous and/or mucilaginous material (biofilm or microbial slime) that reduces the efficiency of the plant (biofilm has very low thermal conductivity) and whose accumulation can lead to the tower bundles clogging and the lines occlusion.

Some microbial species that can grow in water of an evaporative cooling system, then turn out to be potentially harmful to health if inhaled in the form of aerosol (*Legionella Pneumophila*) and their concentration in the plant must be carefully checked.

Lastly, in case the contamination takes higher values for long periods, evil-smelling (hydrogen sulphide, volatile fatty acids) and/ or corrosive substances may originate.

3. Tower water management parameters

3.1 Concentration factor

The concentration factor (CF) is defined as the ratio between the concentration of salt in the water that circulates in a plant and the concentration of salts of the make-up water (as a first approximation equal to the ratio between the conductivity of the two waters).

Operating with excessive concentration factors implies that the content of scaling salts in the water becomes very high, facilitating the formation of inorganic deposits; since then also the content of alkaline species increases with the CF there is a steady increase in pH that can exceed the maximum acceptable threshold for galvanized steel causing corrosion.

Finally, high concentration factors imply high residence times of water in the system and this favours the formation of microbial slime.

The maximum concentration factor that can be kept in a plant depends on the chemical-physical characteristics of make-up water, by way of illustration the following table provides a maximum value of CF as a function of M alkalinity and calcium hardness of water, considering a water surface temperature of 50°C; it is clear that the correct maximum CF for a plant must be indicated by a company expert in water treatment that obtains it based on the characteristics of make-up water, on the type of treatment applied and on the characteristics of the circuits.

		Durezza calcica (ppm $CaCO_3$)															
		25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400
Alcalinità M (ppm CaCO3)	25	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	3,0	3,0	3,0	3,0	3,0	3,0
	50	4,0	4,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0
	75	4,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0
	100	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	2,8	2,8	2,8	2,7	2,6	2,6	2,5
	125	3,0	3,0	3,0	3,0	3,0	2,9	2,8	2,7	2,6	2,5	2,4	2,4	2,3	2,2	2,1	2,1
	150	3,0	3,0	3,0	2,9	2,7	2,6	2,5	2,4	2,3	2,2	2,2	2,1	2,1	2,0	1,9	1,9
	175	3,0	3,0	2,7	2,6	2,5	2,3	2,2	2,1	2,0	1,9	1,9	1,8	1,8	1,8	1,7	1,7
	200	3,0	2,8	2,5	2,3	2,2	2,1	2,0	1,9	1,8	1,8	1,7	1,7	1,6	1,6	1,6	1,5
	225	3,0	2,6	2,3	2,1	2,0	1,9	1,8	1,7	1,7	1,7	1,6	1,6	1,5	1,5	1,5	1,4
	250	3,0	2,4	2,1	2,0	1,8	1,7	1,7	1,6	1,6	1,6	1,5	1,5	1,4	1,4	1,4	1,4
	275	2,8	2,3	2,0	1,8	1,7	1,6	1,6	1,5	1,5	1,5	1,4	1,4	1,4	1,3	1,3	1,3
	300	2,6	2,1	1,9	1,7	1,6	1,5	1,5	1,4	1,4	1,4	1,3	1,3	1,3	1,3	1,2	1,2
	325	2,5	2,0	1,8	1,6	1,6	1,5	1,5	1,4	1,4	1,4	1,3	1,2	1,2	1,2	1,2	1,2
	350	2,3	1,9	1,7	1,6	1,5	1,5	1,4	1,3	1,3	1,3	1,3	1,2	1,2	1,2	1,2	1,2
	375	2,3	1,8	1,6	1,5	1,4	1,4	1,4	1,3	1,3	1,2	1,2	1,2	1,2	1,2	1,2	1,2
	400	2,1	1,7	1,6	1,5	1,4	1,3	1,3	1,3	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2

Calcium hardness (ppm $CaCO_3$)
M alkalinity (ppm CaCO3)

To control the concentration factor of a system it is necessary to properly set the purge system flow rate.

3.2 Purge

The word purge means the proportion of water that is voluntarily removed from the plant to allow control of the chemical and microbiological characteristics of water circulating in it.

Flow control of purging is essential to prevent scaling and corrosion and for controlling bacterial contamination.

The methods used to control the purges rate are two: continuous purging or purge controlled by conductivity meter.

Using continuous purging moves away a constant amount of water from the plant through a valve located on the basin of the towers or on the return line from the users. This system is simple and requires no maintenance; in contrast it does not allow the optimization of water consumption (the extent of the purging is not modulated by the actual timed operating speed of the tower) and if purging is carried out by a line with small thickness, over-concentration phenomena may occur as a result of the line filling.

Instead when the system is controlled by a conductivity meter the bleed valve (always located on the basin of the towers or on the make-up line) opens when the conductivity value of recirculating water exceeds a preset threshold and remains open for the time necessary to bring the conductivity of the tower water below the threshold value. This system (of which there are many variants) is used to optimize the consumption of water, but it requires regular maintenance of the conductivity meter.

4. Water treatment and chemical conditioning

NOTE: No chemical/physical or chemical conditioning treatment ensures prevention of corrosion, scale deposit or microbiological fouling if the concentration factor of the system is not effectively controlled.

4.1 Prevention of scale deposit

The prevention of inorganic scale deposit is achieved primarily by controlling efficiently the concentration factor maintained in the plant.

It is then indispensable to make a proper chemical conditioning of water that includes the addition of additives with descaling action, the choice of the correct concentration factor as well as the design of chemical conditioning treatment must be performed by companies experienced in treating this type of plant.

In the event that the make-up water results to have high values of calcium hardness and/or M alkalinity is possible that, even applying an excellent chemical conditioning, the maximum concentration factor at which a plant can operate is moderate and resulting in the consumption of large quantities of water; but it is possible to adopt two strategies to increase the CF by changing the characteristics of the make-up or recirculation water.

The first strategy, widely used for small plants, plans to reduce the calcium content in make-up water through its total or partial softening. The application of a softening process is simple but not devoid of contraindications: the use of fully softened water is not recommended for plants made of galvanized surfaces, the regeneration of water softeners provides for the use of concentrated solutions of sodium chloride which must then be disposed of in accordance with current legislation.

The second strategy is to control the pH of recirculation water through the dosing of acid solutions (usually sulphuric acid solution of 40%). This procedure, simple and extremely effective, requires the regular maintenance of the pH control system and the assistance of a company expert in water treatment. With this system there are disadvantages associated with the disposal of sewage and particularly high values of CF can be reached; however the risks associated with the use of potentially dangerous substances must be carefully evaluated.

4.2 Prevention of fouling of microbiological origin

The prevention of microbiological fouling is achieved by efficiently controlling the concentration factor maintained in the plant and by dosing in the recirculation water substances capable of reducing the concentration of viable micro-organisms (biocides).

The types of available biocides for the control of microbiological contamination in tower water are very numerous and just as many are the rules for applying them, since then biocides have a significant environmental impact and some of them (those capable of releasing free chlorine) are subject to draining restrictions it is advisable to rely on a company expert in water treatment for the design of this type of treatment.

4.3 Prevention of Legionellosis

Legionellosis is a serious disease that has symptoms similar to pneumonia and that can be lethal if not properly diagnosed and treated. Legionellosis infection is contracted when aerosols containing Legionella pneumophila bacteria are inhaled; in the world cases of multiple infection have been reported caused by aereosol produced by cooling towers, whose waters were not properly treated and controlled.

Almost every country has specific laws regarding the protocols for the prevention of Legionellosis and there are groups and organizations that produce guidelines regarding this matter; the various regulations and laws all agree with the fact that it is not sufficient to make a chemical conditioning treatment to ensure no risk of Legionellosis contamination, but rather that proper prevention measures must be based primarily on microbiological monitoring of recirculating water, and only later o