/ Hybrid Cooling Towers

Cooling Towers without visible plume /

SPX Cooling Technologies

Balcke | Hamon Dry Cooling | Marley

/ Visible plume – an avoidable problem /

Every wet cooling tower generates a visible plume which can be very extensive particularly in cold and/or humid weather. It is the physical functioning principle of a wet cooling tower, in which the water to be cooled is essentially cooled by evaporating a small proportion thereof, which causes the plume. When it leaves the cooling tower, the visible plume therefore consists only of small water droplets and is normally neither dangerous nor environmentally hazardous.

Such plume can, however, lead to negative reactions such as:

- complaints and objections from local residents
- problems relating to acceptance and approval at plant locations
- corrosion and ice formation on components in the vicinity
- endangering of nearby traffic routes (roads and railways) in the case of larger cooling towers
- in the case of very large cooling towers a considerable amount of shadow is caused in the vicinity which can have negative effects, for example, on agricultural areas

Visible cooling tower plume in most cases harmless but nevertheless giving grounds for complaint, in particular in cold weather and when there are traffic routes in close proximity

This was the reason why SPX Cooling Technologies developed the concept of the "hybrid cooling tower" several decades ago. In principle this hybrid cooling tower is a wet cooling tower in which the plume is mixed with a dry, hot air stream prior to leaving the cooling tower. This air stream is generated in heat exchangers, the water to be cooled serving as the heating medium. No additional energy is therefore required to heat the air. The quantity of hot air added is such that the plume leaving the cooling tower is undersaturated and remains undersaturated even when it is mixed with the ambient air. Consequently it remains invisible.

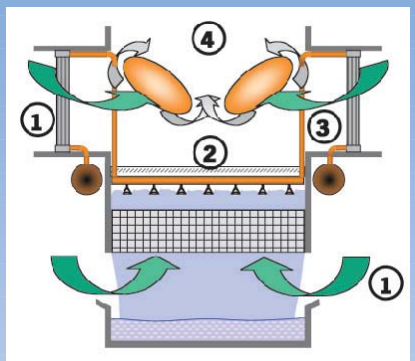
Normally, cooling with the plume being invisible is only possible when a dry cooling tower without evaporation is used. This involves, however, higher capital investment costs and the cold water temperature achieved are higher compared to those of a wet cooling tower.

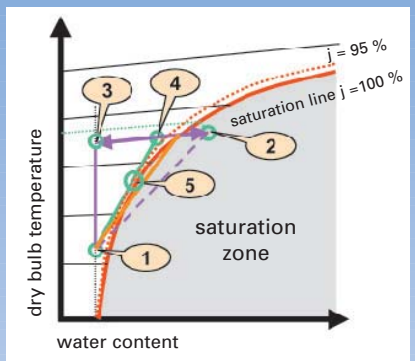
Hybrid cooling towers of the SPX Cooling Technologies design are amongst the technically most advanced cooling towers of this type. To date we have built such towers exclusively as round structures which are best suited to the large flow rates of water to be cooled *(please refer to pages 6/7)*. Some examples of our hybrid cooling towers are set out on the following pages.

The problem: visible plume

The solution: SPX Cooling Technologies hybrid cooling tower

/ Physical functioning principle of a hybrid cooling tower /

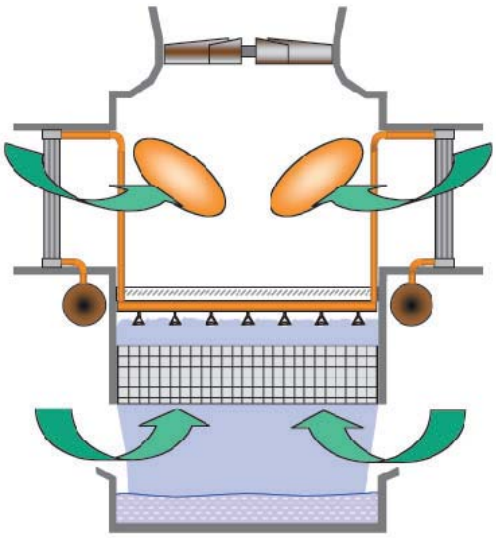




Principle sketch of a hybrid cooling tower. The method of operation of a hybrid cooling tower is illustrated in the "Mollier h, x-diagram" on the right side.

1. Ambient air being fed to the cooling tower.
2. Plume leaving the cooling fill (the so-called wet section of the cooling tower). When emerging from purely wet cooling towers, this plume mixes with the ambient air. In this case the cooling tower plume mixes with the ambient air along the mixing line (dotted connecting line between 1 and 2).
3. Heated air stream leaving the dry section heat exchanger. The air is heated in the dry section at a constant level of humidity.
4. Mixed air streams from wet and dry sections. The air leaves the cooling tower in this state. The mixing line (green connecting line between 1 and 4) distinguishes the possible degrees to which the exhaust air is mixed with the ambient air.
5. Smallest distance between the mixing line and the saturation line (humidity of the air = 100%) when the air leaving the hybrid cooling tower mixes with the ambient air. If the mixing line does not intersect or touch the saturation line, then no water condenses out. In this case the plume is not visible.

/ The most frequent design – cell-type hybrid cooling towers /



Cell-type hybrid cooling tower with induced draught fan

SPX Cooling Technologies hybrid cooling towers of a cell-type design are excellently suited to all types of application, e.g. in power stations, chemical plants, refineries, refrigerating and air-conditioning plants etc. They can be made of different materials such as concrete, timber, steel, FRP.

As hybrid cooling towers are primarily used in plants where disturbing effects on the surroundings must be avoided, they are normally equipped with sound prevention components such as low-noise fans and sound attenuators.

Fig. 1

Fig. 2

Cooling tower made of concrete for a Spanish paper mill. Adjustable roller shutter doors can be seen in front of the heat exchangers. These control the required hot air flow rate to ensure plume-free operation. *(Fig. 1)*

Hybrid cooling tower made of concrete with sound attenuators for a power station in The Netherlands. *(Fig. 2)*

Hybrid cooling tower made of concrete and equipped with sound attentuators for a German chemical plant. *(Fig. 3)*

Hybrid cooling tower made of timber for a British cogeneration plant. *(Fig. 4)*

Hybrid cooling tower made of concrete and equipped with sound attenuators for an Austrian combined heat and power station. *(Fig. 5)* This plant has separate forced draught fans for the wet and dry sections. It is therefore possible to achieve extremely low sound emissions on the side of the cooling tower away from the fans. As in the case of round cooling towers, it is possible to control the wet and dry sections optimally *(please refer to pages 6/7)*.

Fig. 3

Fig. 4

Fig. 5

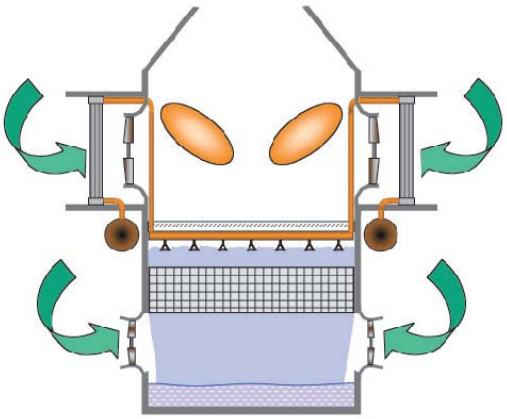
/ The top class – Hybrid cooling tower of a round design /

SPX Cooling Technologies hybrid cooling towers are the ideal solution for power stations and chemical plants in which large water flows need to be cooled. Recirculation and interference occur in large cell-type cooling towers, i.e. the hot cooling tower plume is sucked back into the air inlets. This significantly reduces the thermal performance of the cooling tower and additional cells would have to be built in order to compensate for the reduction in performance. Recirculation and interference problems are hardly ever experienced in round cooling towers due to their greater overall height.

A round hybrid cooling tower also requires less space than a large cell-type plant. Finally less piping is needed, as in round cooling towers only one hot water pipe leads to the cooling tower whilst in cell-type cooling towers one individual pipe has to be allocated to each cell.

Round hybrid cooling towers have separate forced draught fans in front of the wet and dry sections. Whilst the speed of the wet section fans is adjusted to ensure the required cooling water temperature, the appropriate speed adjustment of the dry section fans controls the required hot air flow rate for plume-free operation. Optimal, energy-saving process control can therefore be achieved in such cooling towers.

Another positive aspect is the architectural design of hybrid cooling towers.



Hybrid cooling tower with forced draught fans

Hybrid cooling towers of a round design equipped with sound attenuators for a combined heat and power station in Germany. *(Fig. 1+2)*

Round cooling tower for an Italian refinery. *(Fig. 3)*

Hybrid cooling tower of a round design equipped with sound attenuators for a German nuclear power plant – the definite world champion of its class. *(Fig. 4)*

Fig. 1

Fig. 2

Fig. 3

Fig. 4

/ Key components of a hybrid cooling tower /

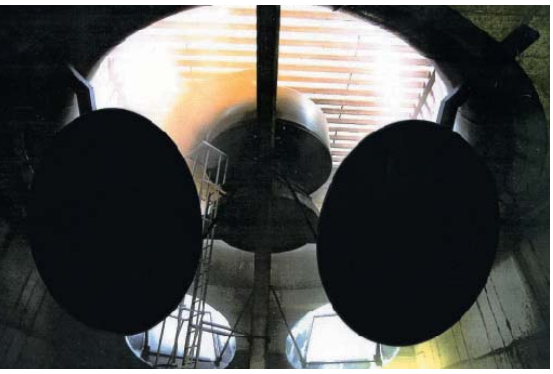


Fig. 1

/ Components essential to the functioning of a hybrid cooling tower /

- Mixing ducts or mixing discs *(Fig. 1 and 2)*
- Low-noise fans *(Fig. 3)*
- Heat exchangers for the dry section *(Fig. 4)*
- Rubber ball cleaning system for the inside of the heat exchanger tubes
- Pressurised water cleaning system for outer finned tube surfaces
- Evacuation equipment
- Bypass systems

/ Heat exchanger – quality at the highest level /

SPX Cooling Technologies heat exchangers are produced at the company's own production facilities and guarantee the highest quality. The production staff can select from a wide range of materials such as C-steel, stainless steel, nonferrous metal, aluminium in order to provide the appropriate tube material for any medium.

C-steel, stainless steel, copper or aluminium are used as fin material for the finned heat exchanger tubes. When tubes or fins are made of C-steel the finished tubes are hot-dip galvanised to protect them against corrosion.

/ Fans – low sound power level but a high degree of efficiency /

Low-noise fans are an absolutely essential component of an environmentally sound hybrid cooling tower design.

The low-noise fan drives and the invisibility of the plume contribute significantly to compliance with the optical and acoustic requirements of environmental regulations.

The low-noise running of the fans designed especially by SPX Cooling Technologies ensures that optimal efficiency is achieved at a low sound power level.

Fig. 2

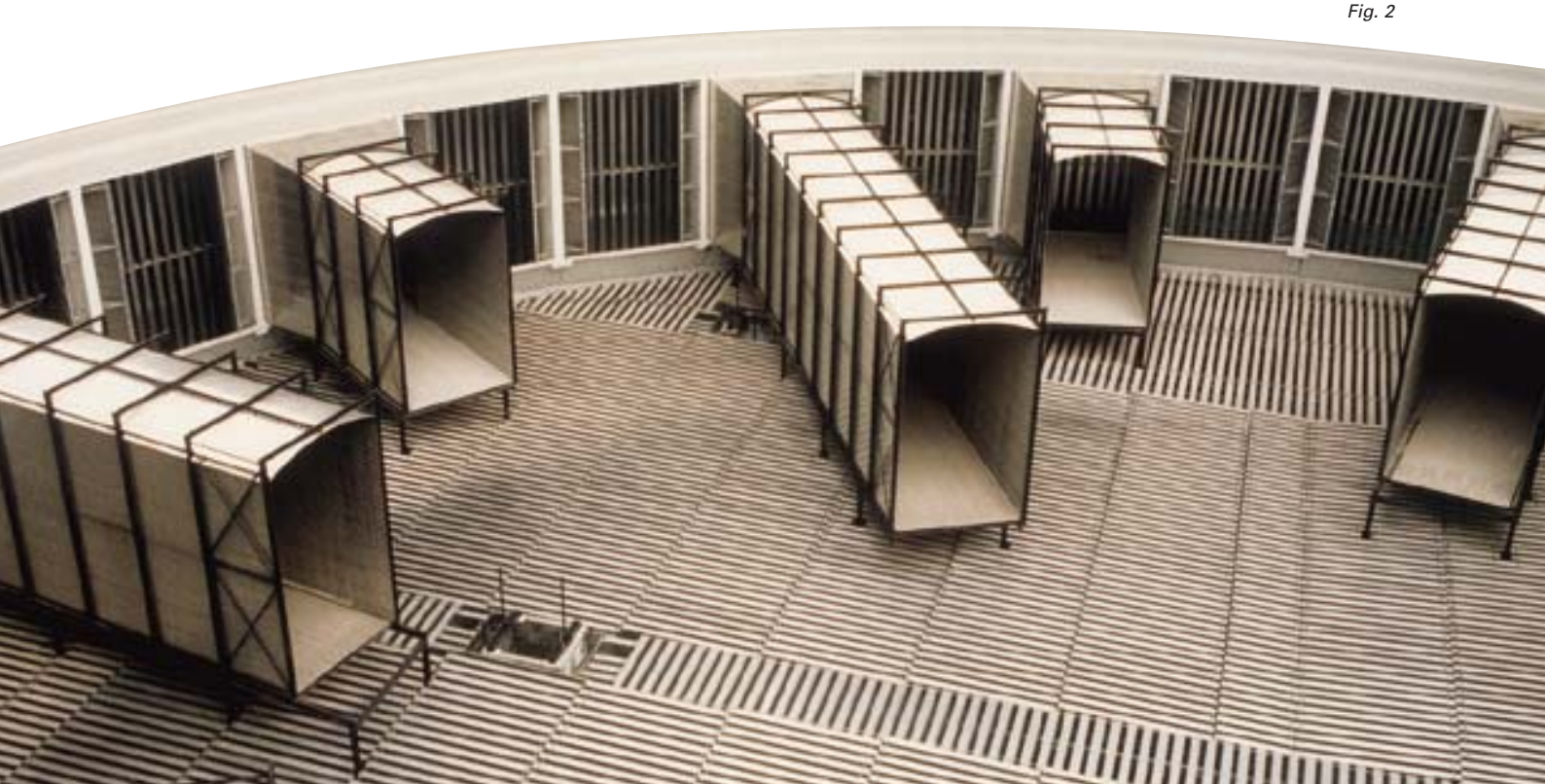


Fig. 3

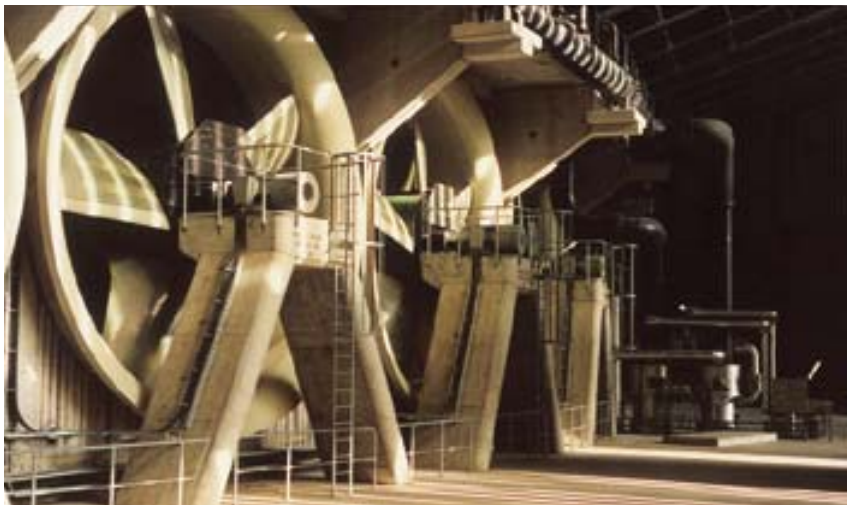


Fig. 4

/ Mixing systems – patented efficiency /

The mixing systems patented by SPX Cooling Technologies ensure compliance with the guaranteed invisibility of plume. Appropriately designed mixing discs and mixing ducts generate the vortices required to mix the immense air flows. Effectiveness and low pressure drop are the main features of these mixing systems.

/ Cleaning equipment – custom-built for easy maintenance /

A custom-designed heat exchanger for the dry section requires an appropriate cleaning system in order to keep the fouling factor as low as possible.
Rubber balls ensure that the inner tube walls are kept clean during continuous operation in a large cooling tower. In cell-type cooling towers it is preferable to use a cleaning fluid. Manual or semi-automatic water jet cleaning equipment ensures thorough cleaning of the tube outer surfaces/fins. The cleaning equipment is used once or twice per year.

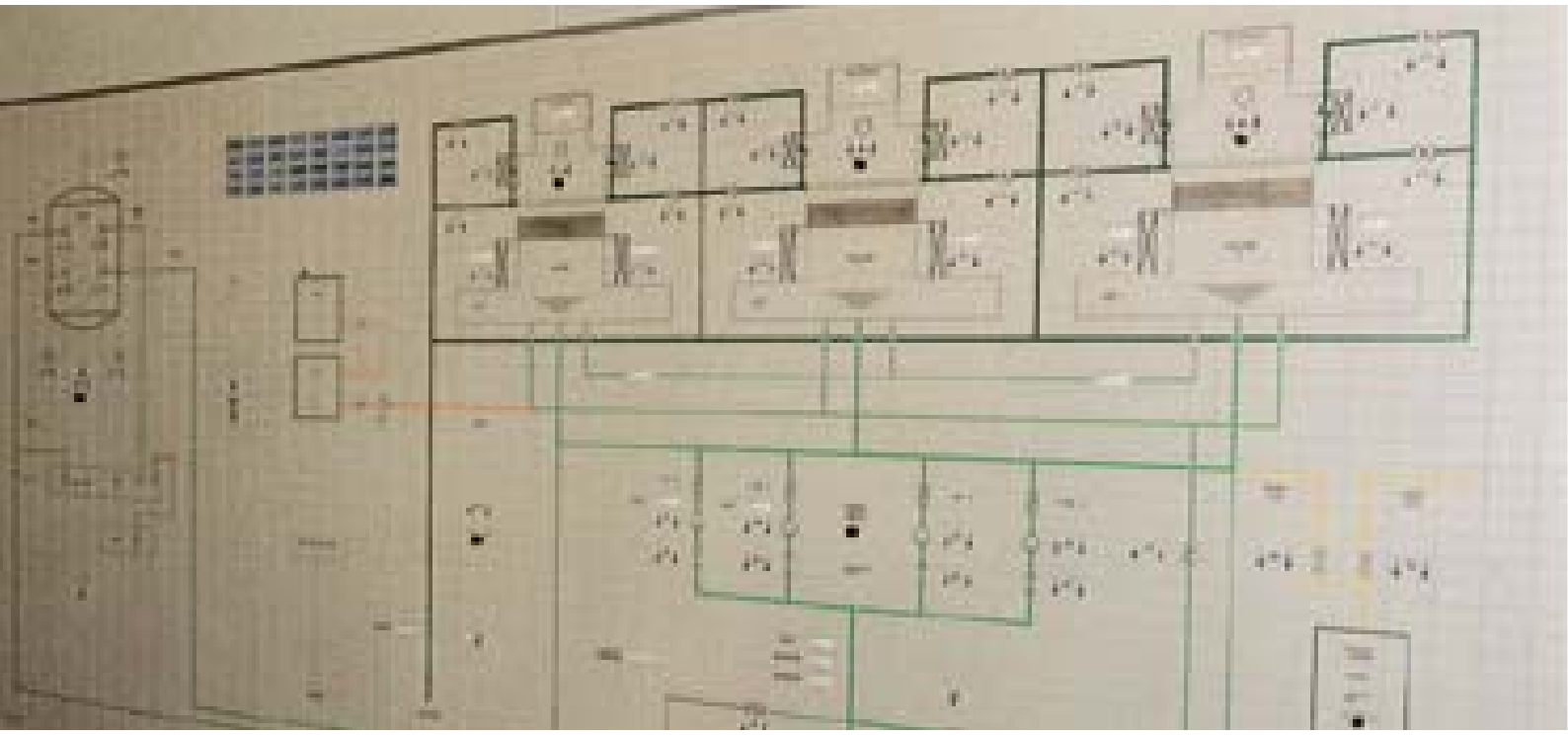
/ Evacuation – only applied when required /

The syphon-principle mode of operation has to be applied in order to operate the dry section economically. Accumulation of inert gases may disturb or interrupt the syphon effect. It may be necessary to use evacuation equipment depending on the design and configuration of the heat exchanger.

/ Bypass systems – flexible mode of operation /

In principle it should be possible to operate a hybrid cooling tower purely as a wet cooling tower or purely as a dry cooling tower in order to guarantee 100% availability. To do this, the plant section not in operation must be suitably and reliably bypassed. Controlled valves in conjunction with overflow weirs ensure absolutely reliable operation.

/ Automatic process control and instrumentation – Guarantee for optimal operation /



Control panel for a hybrid cooling circuit

When operating hybrid cooling towers it is extremely important to ensure optimal adjustment to the mode of operation so that:

- operation is plume-free irrespective of the changing ambient meteorological conditions
- the cooling water temperatures being a function of the cooling water flow rate, the heat rejection rate and the changing ambient air conditions are as required
- power consumption of the cooling tower fans is minimised

The automatic hybrid cooling tower process control developed by SPX Cooling Technologies which comprises the latest instrumentation and control technology including Programmable Logic Control (PLC) systems guarantees:

- fully automatic operation to ensure invisibility of plume or minimum plume
- maximum profitability with minimal power consumption
- maximum reliability and availability of the plant
- minimal personnel expenses

The automatic process control for hybrid cooling towers is designed and engineered by an experienced team of experts at SPX Cooling Technologies who are well-versed in cooling tower operation and have specific technical expertise in instrumentation and control technology.

Upon request, we can also supply optimal automated process control for the entire cooling circuit.

/ Teamwork for the benefit of our customers /

/ Together we are strong /

Specialists for thermodynamics, hydraulics, instrumentation and control, structural engineering and civil engineering work together in our interdisciplinary engineering teams.

Our company Research and Development Centre is fitted with state-of-the-art equipment and employs a highly qualified staff to meet your requirements.

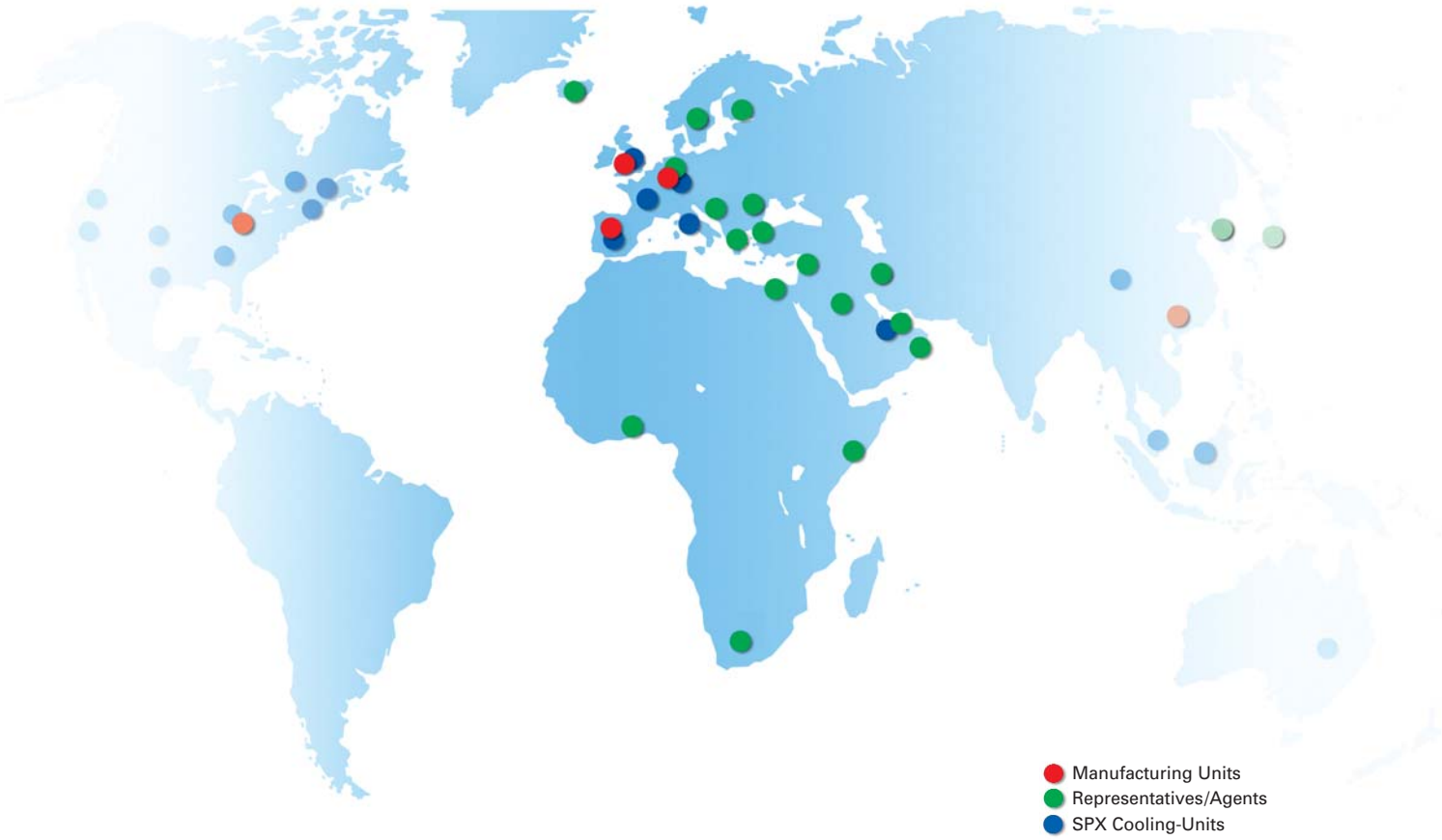
We are also in contact with colleges of advanced technology and universities to exchange information on a regular basis. Your assignments, even unusual problems are in the very best of hands at SPX Cooling Technologies. Your competent partner.

/ On the spot with good advice and assistance /

This gives you an insight into hybrid cooling towers. If you have any questions or require information from us about any specific problems relating to cooling systems just phone us or write to us.

"Us" being SPX Cooling Technologies GmbH or our affiliated companies in Europe and overseas. We are always open to learn about interesting problems facing our customers. And in most cases we can provide the solution. Because "tricky cases" are our speciality. Challenge and obligation in one.

/ Worldwide Competence in Cooling /



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