



TMC产品维护说明书

TMC Product Maintenance Manual

引风混合流密闭式冷却塔

Induced Draft Closed Cooling Tower

首先感谢贵公司购买廷亚冷却塔。本说明书以标准型冷却塔为对象，针对安装、运行、操作、检修时的安全，及维持性能等方面进行具体说明。请在使用前先仔细阅读本说明。请保存好本说明书，以便随时阅读。如果更换负责冷却塔的操作、保修、检修等方面的有关人员，本说明书请一定转交。

Firstly, thank you for buying Tyacht cooling tower. This manual focuses on describing the installation, running, operation, servicing safety and maintenance performance of standard cooling tower. Please read this manual carefully before you operate the product, and please keep it properly for easy checking in the future. If persons concerned who are responsible for operating, guaranteeing and servicing cooling tower are replaced, this manual must be transferred.

上海廷亚冷却系统有限公司
Shanghai Tyacht Cooling System Co.,Ltd

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安全上的注意事项：

使用前请详细阅读本维修说明书。

阅读后，请保存在容易看见的地方。

注意标示记号的意思：

-  表示「重要警告·注意」
-  表示「禁止」
-  表示「请不要接触、进入」
-  表示「请不要拆卸、修理」
-  表示「请一定要实行」
-  表示「请配地线」

标有「警告」的场所，如果错误操作，可能会造成死亡或重大伤亡事故。

标有「注意」的场所，如果错误操作，根据情况可能会造成重大伤害、损失事故。

1. 设计、安装方面的注意事项

选择安装场所，请注意以下注意事项：

- 请在通风良好、清洁的场所安装。
- 请避开灰尘、酸性气体排放多的场所。
- 请避开有烟囱，及其它热源机器的场所，防止受排气热、辐射热的影响。
- 请把塔体水平放置，并用固定螺栓牢固固定基础。
- 因为空气从四面百叶窗处吸入，冷却塔和墙壁等其它障碍物间的距离请参照产品规格书。如果吸入空气量比设计值偏低，会导致排热能力不足。
- 请注意不要使从冷却塔内排出的空气在循环后再次吸入塔内，发生短路现象。
- 在外墙的高度比塔体高的场合，推荐安装直角配管，容易受外风影响的场合，推荐安装直角配管或弯管等对策。障碍物的高度应与风机高度相同或在风机高度以下。否则障碍物比风机高的场合，容易发生气流短路。

设计配管和周边时请注意以下事项：

- 请确认图纸上标有的进出口配管的方向。
- 请确认防振架台和基础孔位置。
- 设计循环水配管时，请注意不要把管路的抵抗力设计的较大，并且不要把配管上下移动范围设计的过大。
- 塔内配管型的场合配有调节阀门，请在冷却塔的进口管安装阀门，以便能够调整供给各水槽的水量。
- 确保排污管和排污阀安装在水系统水泵出口处，并可方便排污。
- 请使用管径在接口管径之上的配管。
- 请在冷却塔外的循环配管内，并在配管出口附近的地方安装过滤网。
- 选定循环水泵时，请适当选型。
- 请注意不要把排水管接管的长度配置太长，并且请配大口管径。
- 在下部水槽安装防冻电加热器时，推荐配套使用水位警报器。
- 请在冷却塔的循环水管和水泵之间，且要在冷却塔的上部安装膨胀水箱。由于循环水系统配管是密闭回路，必须要有吸收水的膨胀水箱。有必要补充从循环水泵的压盖密封垫滴下的水。
- 冬季运行时，请安装下部水槽防冻电加热器（散水系统用）、循环水防冻电加热器（循环水系统用）、及安装防止循环水冻结的辅助水泵，辅助运行冷却塔内循环水。详细内容请向本公司询问。

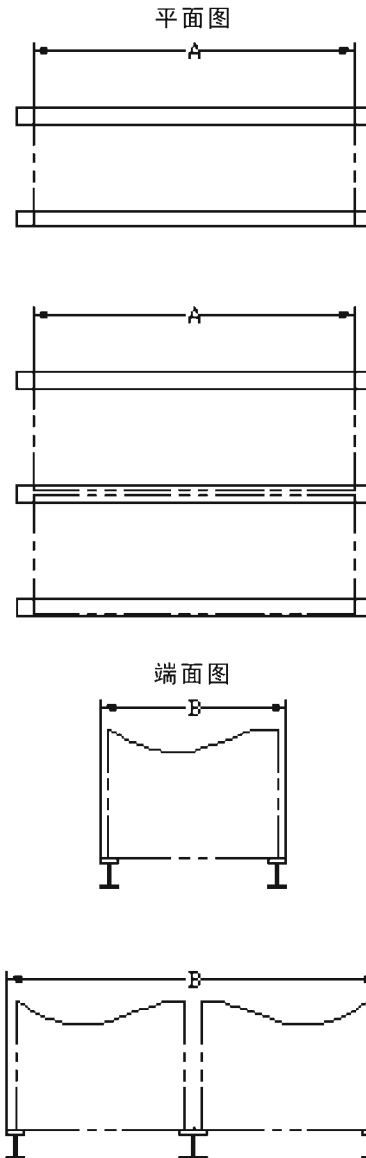
2. 设备安装前存放的注意事项

安装前存放设备时不得用油布或其它覆盖物覆盖在机组上面，机组被覆盖可能会造成过热使得PVC挡水板及冷却塔填料损坏。长期保存时，应定期旋转风机和风机轴，润滑所有的轴承。在试运转时应清理轴承并加上新的润滑脂。

3. 钢结构基础设置注意事项

宽度B大于7.3米的机组要求用三根足够长度的“工”字钢梁作为机座，钢梁用来固定机组外底部法兰的下表面。机组底部法兰设有19mm直径的安装孔，供与“工”字钢梁紧固螺栓之用（详见正式图纸所提供的螺栓孔精确位置）。

“工”字钢的尺寸应根据工程经验确定，“工”字钢的最大挠度为机组长度的 $1/360$ ，并且不得超过13mm，“工”字钢的挠度也可按照55%的运行重量以均布载荷进行计算（运行重量参见图纸）。“工”字钢必须在机组放上之前校正好水平，不能用垫片塞在水盘段法兰和“工”字钢之间来找水平，否则将不能得到良好的纵向支撑。“工”字钢和地脚螺栓由其他厂家提供，机组的重量、尺寸和技术数据参见机组外型图。



4. 启动、运行、停机时的注意事项

下表所列为启动、运行和停机期间建议的维护工作及其周期。对于各项所需的维护工作，必须遵从本说明书“维护程序”部分中的步骤。

表一 闭式冷却塔的建议维护工作

维护工作项目	每月	每季	启动	停机
检查冷却塔的一般状况	★		★	★
如有必要，检查并清理：				
(1) 进口过滤器			★	★
(2) 冷水盘/过滤器	★		★	★
(3) 进风导流板	★		★	★
(4) 盘管	★		★	★
检查调整水盘水位	★		★	
检查补水阀的运行	★		★	
检查泄水率并调整	★		★	
检查传动带的状态和张力	★		★	
润滑风机轴承		★	★	★
润滑油电机底座调整螺丝		★	★	★
清理风机电机表面		★	★	★

注意：

- 1) 建议维护工作间隔为一般情况下间隔，恶劣的环境条件可能需要更为频繁的维护工作。
- 2) 当冷却塔在环境温度低于冰点时运行，应该更频繁地检查（参见“冬季运行”）。
- 3) 新传动带在最初的24小时运行后以及之后的每个季节必须重新调整张力。

警告：

在进行任何维护检查之前，确认所有电源已经断开并锁定在关闭状态。

5. 初次和季节性启动

在初次启动之前或停机期之后应对冷却塔进行彻底的检查和清理：

- 1) 清除塔内和进风导流板上的所有碎渣、树叶和灰尘等；
- 2) 拆下进口过滤器，清理后重新安装；
- 3) 排干冷水盘（水盘过滤器就位），冲洗冷水盘以除去积聚的灰尘杂物；
- 4) 拆下水盘过滤器，清理后重新装上；
- 5) 用手转动风机，确保无卡阻现象；
- 6) 启动风机电机，检查风机的转动方向是否正确；
- 7) 季节性启动时，调节风机传动装置上的传动带的张力；
- 8) 检查由浮球控制的补水阀，确保阀能自由动作；
- 9) 季节性启动前，润滑风机轴承；
- 10) 向冷水盘注入清水至溢出水位：
 - A. 初次启动或在冷水盘被完全排干的情况下重新启动时，应进行初始生物杀除处理。（参见“水处理”部分）
 - B. 在停机期之后，当冷水盘中的水未被完全排干时，建议采用适宜的高强度杀除生物处理，以清理积聚的生物残余物。
- 11) 将补水阀上的浮球设置为当浮球低于溢水位1.5cm左右时，阀关闭；
- 12) 启动循环水泵，按设计值调节系统水流量；
- 13) 打开泄水管上的阀门（由其他供应商提供），调节泄水量至建议流量；（参见“水处理”部分）
- 14) 检查风机电机的三相电压和电流，电流不能超过铭牌上的数值。长期的停机后，在启动电机前必须用高阻绝缘检测计检查电机的绝缘性能。

注意：

- 1) 频繁开停循环可能导致电机过热，控制部分应设定为每小时最多允许开停次数6次。
- 2) 在经过二十四小时的负载运转后，应该进行以下工作：
 - ① 检查冷却塔是否有异常的噪声或振动；
 - ② 检查冷水盘的运行水位，如有必要，调节补水阀；
 - ③ 重新调整传动带的张力；
 - ④ 清理进口过滤器；
 - ⑤ 确认水泵电机接线端子盒内各接线端子已经按照国家标准/规范锁紧、牢固，以避免接线端子发生虚接短路。

6. 季节性停机

当冷却塔需要长期停机时应完成以下工作：

- 1) 排干冷水盘和所有暴露于冰点温度以下的管路中的水；
- 2) 清理进口过滤器；
- 3) 在冷水盘过滤器就位时冲洗冷水盘，将冷水盘的排水口打开，让雨水和融化的雪水能流出冷却塔；
- 4) 清理冷水盘过滤器并重新装上；
- 5) 遮盖风机排风口以阻挡灰尘杂质进入；
- 6) 润滑风机轴承和电机座调节螺丝；
- 7) 关闭补水管路上的截止阀（由其他供应商提供），并排干所有暴露在外的补水管路；
- 8) 检查冷却塔钢制部分腐蚀防护装置的完整性。

7. 维护程序

1) 冷水盘和过滤器

要经常检查冷水盘，清除积聚在盘中或过滤器中的杂质，如有必要，调节浮球以保持设定的运行水位。每季度，或在必要时排干整个冷水盘，用清水冲洗掉运行期间积聚到冷水盘中和填料表面的淤泥和沉淀物。如果不定期清理，这些沉淀物会有腐蚀性，导致保护层破坏。在冲洗冷水盘时，过滤器应就位以防止沉淀物再次进入冷却塔系统。冲洗完冷水盘，过滤器应拆下，清理后在冷水盘重新注水之前装上。

2) 补水阀

应每月检查补水阀，如有必要，进行调节。阀本身每年检查是否渗漏，如有必要，更换阀座，为正常运转，补水阀给水压力必须保持在1.0~3.5bar之间。初次设定冷水盘水位时，调节蝶型螺母至当冷水盘中的水位达到低于溢水管1.5cm时，补水阀能完全关闭。在设计热负荷及普通的城市水压（1.0~3.5bar）下，运行水位（从盘底部计）的设定值请参见下表二。

注意：

如果启动时热负荷低于设计负荷，将导致运行水位大于建议值，补水阀浮球可能不得不调节以获得建议的运行水位，在初次的二十四小时运行期间应密切监视冷水盘，如有必要，调节水位。

表二 运行水位

冷却塔型号	冷水盘水位高度
闭式系列冷却塔所有型号	按照实际情况调节 推荐 15CM

3) 电机

闭式系列冷却塔使用的标准电机为TEAO全封闭电机，带有永久性润滑的球轴承。轴承、轴、和线圈有特殊的防潮保护。运行期间需要完成的唯一维护工作为每季度清理电机外表至少一次，以保证电机的冷却。长期的停机后，重新启动之前检查电机的绝缘性能。

4) 风机轴承

风机轴由两个球轴承支撑，每个都装有润滑装置和锁环防潮。请按照下列说明润滑轴承：

初次启动：如果冷却塔在工地放置一年以上，初次运行之前轴承应注入新黄油。

季节性启动：启动之前轴承注入新黄油。

运行期间：每运行2000小时或每三个月润滑轴承，以先到期的一个为准。

季节性停机：长期存放或停机之前，轴承注入新黄油。

注意：

风机轴承只能用手持式注油枪润滑，不要使用高压润滑枪，因为可能导致轴承密封断裂和损坏。

环境温度范围为-54°C-120°C时，只能使用下列防水黄油润滑轴承。

American -Rycon #3

Keystone -84EP Light

Shell -Aeroshell #17

Chevron -SRI

5) 可调电机座

电机座调节螺丝应该一年两次用优质黄油（如以上润滑风机轴承所推荐使用的黄油涂盖）。

初次启动：调整传动带的张力和直线度；

运行：

初次运行或安装新传动带之后，运转二十四小时后必须调节张力，然后每月检查张力，如有必要，进行调节，每三个月至少调节一次；季节性启动：重新调节传动带张力。

注意：

检查传动带张力时，沿着传动带放一把直尺跨过两个带轮，然后用尺测量传动带的挠度，在两个带轮跨度中间在整个传动带宽度上用手均匀地施加一个中等程度的力（大约18Kg），如果传动带挠曲范围在6.5mm~9.5mm之间，则传动带已经充分张紧。

为确保获得最大的传动带寿命，应每年检查传动带直线度。对标准形式的传动和节能风机系统传动，检查时放一把直尺跨过主动和从动带轮，当传动带的直线度已经正确调整好之后，直尺将接触到全部四个点，距离四点接触的建议偏差值不大于1.6mm，如有必要，调整直线度。松开电机带轮，以风机带轮为基准调整直线度。

8. 冬季运行时的注意事项

冷却塔的散热能力是按照夏季最热天气设计选型的，在其他季节，特别是冬季，散热能力就明显过大了。冷却塔的出水温度和环境温度关系不大，主要受湿球温度影响，而湿球温度比环境温度低很多。尽管冷却塔运行时，环境温度高于0℃，冷却塔也可以将管内水降至零下，甚至结冰。冷却塔内循环和外循环水结冰，可能引起配管、散热铜管和塔内其他部件的破裂，为了防止这类事故的发生，冬季防冻特别重要。

为避免冷却塔内的盘管因操作不当造成冻结而影响正常的生产，以下提供冬季防冻的方案，供参考。

1) 外循环防冻

- ①装入防止下部水槽冻结用的水中电加热器。装电加热器时，推荐一同安装水位开关、温度控制器等辅助设备，并设置自动控制，防止电加热器干烧或过度加热。但水盘加热器不能防止水盘外面的水管、水泵和水泵通道的冻结。
- ②在暴露在下部水槽外的外循环管道（连接喷淋水泵）处，包括所有供水和排水管，泵的配管以至溢流接头都应用电热线包裹，并保温以防冻。
- ③长期停机时，排空所有外循环水，并保持下部水槽的排水阀，散水水泵的排水阀打开放置。

2) 内循环防冻（换热盘管内）

- ①加入防冻液，推荐使用工业用乙二醇，但要考虑配套的设备是否允许加入该种物质。比例需根据当地气温进行适当浓度调配。由于乙二醇水溶液的冰点低，在水中的溶解度又大，因此，乙二醇是很好的防冻剂。但是该方案的不足之处为，随着乙二醇溶液浓度的增加，冷却塔的性能可能会略有降低，夏季高温天气，务必排空乙二醇，使用干净的水。
- ②管内防冻装置。任何时候都应在盘管上保留一个辅助负荷，使冷却塔停止时，水温不致降低到10℃以下。对于日开夜停等规律性停机的，可以安装管内旁通电加热器，在停机时，旁通电加热给冷却塔散热铜管提供热量，保证其不结冰。另外，推荐盘管内必须维持最小循环水量。如下表所示：

表三 推荐最小循环水量

型号	最小流量
TMC	M3/Hr
TMC-120~TMC-155	17
TMC-181~TMC-428	25

- ③上述两种方案均需要增加设备，如不希望增加设备来进行防冻，冬季长期停运时可采取排空散热管内的循环水。如用户的管路上没有设置放水口，我方冷却塔设计了放水口。放水时，请同时打开冷却塔排气阀。如有条件，使用高压空气逼出管内的循环水，并保持排气阀、排水阀打开放置。此防冻方法只应在紧急状态下使用，盘管中的水不应需要很长时间才能放空。

4) 其他可能的能量调节方法为包括采用双速电动机、变频驱动、停/开通风机。

以上各项防冻措施，可以单独使用，也可以在系统设计时使用多项。如果在防冻措施上需要更多的信息，请直接联系我公司售后部门，我们将全力为您提供服务。

注意：

频繁的开停循环可能导致电机过热，控制部分应设置为每小时最多允许开停 6 次。

如果冷却塔配有双速电机，低速运行足以防止结冰。

注意：

使用双速电机时，由高速向低速切换时电机的启动装置，应包括一个15秒钟的延时。

周期性地关停风机，对防止结冰或融化进水到导流板上和填料表面积累的冰很有必要。

在恶劣的情况下，周期性的间断工作不足以防止结冰，可能有必要反向运转风机，通过使热风吹过进风导流板来除去积累的冰雪。

注意：

不要反向运转风机超过必要的时间，因为延长反向运转时间会导致风机叶片、风筒或风机罩结冰，损坏冷却塔。

由于存在这种可能，使用反转风机来除冰的冷却塔应配有隔振开关，反向运转必须限制在最多30分钟内，电机控制中应装有正反转之间大约40秒的延时。

使用电加热器场合的注意事项：

- 1) 使用电加热器的场合，请装恒温器，使水温不至于上升到过高温度；
- 2) 为了防止空加热，请确认电加热器发热部分是否浸在水中后，再通电。推荐使用水位报警器或探测开关；
- 3) 关于电加热器的其它使用方法，请参照「冷却塔防止冻结电加热器操作说明书」后使用。

使用防冻液场合的注意事项：

- 1) 根据不冻液的种类、浓度，冷却塔的性能可能会改变。在选定时请注意。
- 2) 由于漏水等原因，会造成不冻液的浓度降低，请定期检查浓度，必要时请补充。

安全注意事项

安全预防

本冷却塔的运行、维护、修理工作只能由具备相应资格的人员进行，这些人员必须完全熟悉本冷却塔相关系统和控制，以及本说明书的程序。为防止人员伤亡或财产损失事故发生，在运输、起吊、安装、运行、维护和修理本设备时必须使用正确的工具，采用正确的步骤。

注意：

所有电气、机械和旋转的机器都有潜在的危险，尤其对于不熟悉其设计制造和运行的人员。因此，应对设备进行足够的防护（在有必要的地方使用防护罩），以防止公众（包括未成年人）受到伤害和设备相关系统、房屋受到损坏。闭式系列冷却塔在设计时已经考虑到所有的日常维护都能在冷却塔的內部或机组外部的基础上完成，不需要到冷却塔顶部进行日常维护。在所有的风机罩、检修板、检修门恢复原有位置以前不允许运行设备。当闭式系列冷却塔的风机转速需要由工厂设定转速加以改变，包括使用变速控制装置来改变转速时，必须采取措施避免在“临界转速”附近运行，否则可能导致风机失效和伤害损坏发生。

为保护维护人员，与本设备相关的每台风机和水泵的电机应装有可锁定于关闭位置的开关，而且这些开关应该位于冷却塔的可视范围之内。

警告：

在没有首先确保风机和水泵电机已经断开并锁定于关闭状态时不要在风机电机和传动装置附近或者机组内部进行任何维修工作。在循环水系统中可能包含化学或生物污染物，如果被吸入吸收，会产生危害。直接暴露在风机排出气体或其漂移气流，或者高压水和压缩空气（用来清理水循环系统）产生的湿气中的人员应戴有经过当地劳动保护部门批准的呼吸保护装置。

9. 检修时的注意事项

- ⚠️ 🚫 除非检修需要，禁止进入冷却塔内部及攀登塔上。
- ⚠️ 为防止检修时发生意外事故，必须两个人以上的专业人员施工。❗
- ⚠️ 检修时必须确认冷却塔的送风机、水泵、电加热器及其它电源已经切断。❗
- ⚠️ 🚫 防冻电加热器被切断电源后一段时间还会继续发热，请注意不要接触。
- ⚠️ 🚫 风机在运行时，绝对禁止进入冷却塔内，及攀登到塔上。
- ⚠️ 🚫 风机在运行时，绝对禁止把手和物品伸进风机内。
- ⚠️ 攀登冷却塔时，请保持身体平衡施工。❗
- ⚠️ 装配电线时，请让专业人员施工。注意有触电、漏电的危险。❗
- ⚠️ 请务必确认电源容量、开关、配电盘容量。❗
- ⚠️ ⚡ 装配电线时，请从地线开始接线。
- ⚠️ 装配电线时，请注意不要导致漏电、短路。❗
- ⚠️ 请在配线后检查。❗
- ⚠️ 🚫 除持有资格的专业人员或者有经验者外，请不要拆卸产品。
- ⚠️ 检修冷却塔时，请注意不要饮食冷却水，并且防止吸入飞沫。检修后必须漱口，并洗手。❗

10. 外部循环水系统维护

排污:

随着水的蒸发，为了避免水分配系统被杂质阻塞，要排放掉相当于蒸发水量的水以防止杂物积聚。塔体侧面装有一台水泵，并设排污管和排污阀，排污阀应全开，以排放适量的水。如果补给水中杂质比较少，则可以减少排放量，但是机组必须进行定期检查，确保没有垢生成，水质保持化学平衡。

水处理:

关于密闭式冷却塔，散布水和外界空气直接接触，使得钙、镁离子浓度过高，因此需要管理管外喷淋水系统。针对水质基准以及管理方法，以下记数据为推荐的标准值，此仅供参考，可根据实际情况调整。

表四 水质的推荐指标 *

参数	范围
Ph值	6.5 ~ 9.0*
硬度 (CaCO ₃)	50 ~ 300 ppm
总碱度 (CaCO ₃)	50 ~ 300 ppm
总溶解固体	<1000 ppm
总悬浮固体	<25 ppm
细菌数	<10000 cfu/ml
氯离子含量 (CL ⁻)	200 ppm 镀锌钢
氯离子含量 (CL ⁻)	400 ppm 304 号不锈钢
氯离子含量 (CL ⁻)	4000 ppm 316 号不锈钢

当镀锌钢机组循环水运行PH>8.或更高时，为防止产生“白锈”，应对镀锌钢结构部件进行钝化处理。应避免使用软化水系统。应避免使用酸，若需要酸来清洗，只推荐使用添加缓蚀剂的可适用于镀锌钢的酸。

浓度系数由泄水率控制，泄水是指从循环水中排掉的那一小部分水，持续泄水率可以用下面的公式计算：

$$\text{泄水率} = \text{蒸发率} / (\text{浓度系数} - 1)$$

蒸发率可以用下列方法确定：

- 1) 蒸发率大约为每1163kw 的散热量为29L/M;
- 2) 蒸发率大约为每100冷吨的制冷量为11.5L/M;
- 3) 蒸发率 (L/M) = 循环水量 (T/Hr) × 温差 (°C) × 0.03.

警告:

不得批量加入化学药剂，应控制化学药剂的加入量。

加压的水分配系统

水分配系统应每月进行检查，以确保其运行正常。经常在水泵开启，通风机关闭的情况下检查喷淋系统。对于引风式机组（直接传动除外），检修门附近的一些挡水板上都装有拉手，从机组外部就可以轻松拆下挡水板，观察到水分配系统。对各种机型都可用开水泵、停风机来检查喷水系统。喷淋嘴实际上不会堵塞，很少需要清理和保养。

如果喷淋嘴工作不正常，这是水盘中的过滤器不工作和水分布管道中积聚了污垢或杂物的一个信号。切断冷负荷，开动水泵，用一个小型尖头探针插入喷淋孔口来回捅动，取出堵塞在喷淋嘴中的脏物。

积累的污垢或杂物特别严重时，可拆去每根支管上的最后两个喷淋嘴，将脏物冲刷到水盘中去。只有在必要时，才把支管或连接管拆掉清理。检查水盘中的过滤器，确保其处于良好状态，并放置正确，以免产生气穴裹进空气。

加药软化水装置的操作

对外循环水的软化加药装置的投放加药剂配方、频次及用量各站按自身水质条件自定，软化水及加药装置的使用按照设备说明书进行，根据情况定期为软化水系统加盐，保持盐箱一直有盐；根据补水量的变化及时调整软化水设备的再生周期，每次调整后的三天时间内加密检测软化水的硬度，确保合格。

每两个月对外循环水水质进行一次化验，化验项目：余氯、总硬度、PH值、浊度。如硬度超标可采取排污或溢流方式进行排水，达到硬度合格。

每半年对内循环水进行一次化验，化验项目：总硬度、PH值、浊度，发现参数有异常及时分析并采取措施。

至少每半月切换一次冷却塔，对冷却塔水池进行清洗；根据情况及时清理冷却塔上部散水槽的散水孔。每次切换冷却塔清洗水池时注意观察铜管的结垢腐蚀情况，发现异常及时处理。

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Safety Considerations:

Please read this manual carefully before you operate the product.

After reading this manual, please keep it in the place where it can be easily found.

Please pay attention to the meaning of the following symbols

-  indicates "important warning · attention"
-  indicates "forbidden"
-  indicates "Don't touch and enter"
-  indicates "Don't remove and repair"
-  indicates "Please be sure to implement"
-  indicates "Please equip earth wire"

In case of misoperation, the death or serious casualty accident may be caused in the place marked with "warning".

In case of misoperation, major injury or loss accident may be caused as the circumstances may require in the place marked with "attention".

1. Considerations for Design and Installation

Select installation site and pay attention to the following considerations:

- Please install the product in a well ventilated and clean place
- Please avoid those places with more dust and acid gas emission.
- Please avoid those places with chimney and other heat source machines to prevent the influence of exhaust heat and radiant heat.
- Please lay tower body horizontally and fasten the base with fixed bolts.
- As the air is inhaled from window-shades all sides, for the distance between cooling tower and other barriers, such as walls, please refer to product specification. If air amount which is inhaled is lower than design value, heat removal capacity will be insufficient.
- Do not let the air exhausted from the cooling tower inhale into the tower again after circulation, which shall cause a short circuit.
- Installation of right-angle tubing is recommended in the place where the outer wall is higher than the tower body. In addition, installation of right-angle tubing or elbow is also recommended in the place which may be influenced by the external wind easily. The height of a barrier should be the same as that of a fan or lower than that of a fan; otherwise, a short circuit of air flow may occur easily if the barrier is higher than the fan.

Please read below information when designing tubing and rims

- Please confirm the direction of outlet and inlet tubing marked in the drawing.
- Please confirm the location of vibration control stand and base holes.
- When circulation water tubing is designed, please don't design the larger resistance of pipeline and don't design the wider scope where the tubing moves up to down.
- The tubing type locations in the cooling tower shall be equipped with adjusting valves. Please install valves in the inlet pipe of cooling tower so as to adjust the water quantity supplied to each water channel.
- Make sure that blow-down pipe and blow-down valve are installed in the water pump outlet of water system for easy blow-down.
- Please use the tubing with pipe diameter above the joint pipe bore.
- Please install the filter net in the circulation tubing outside the cooling tower and in the place near the tubing outlet.
- When selecting the circulating water pump, please select the right model.
- Please don't configure too long connecting pipe of drain pipe and please configure large pipe diameter.
- When antifreezing electric heater is installed in the lower water channel, the water level alarm is recommended.
- Please install an expansion tank between the circulating pipe and the water pump of the cooling tower and above the cooling tower. As the tubing of the circulating water system is a closed loop, the expansion tank which absorbs water shall be equipped. It is necessary to supplement water which is dropped from gland seal of circulating water pump.

- When the product is operated in winter, antifreezing electric heater in the lower water channel (used for diffusion watering system) and antifreezing electric heater of circulating water (used for circulating water system) shall be installed. In addition, auxiliary water pump which prevents the freezing of circulating water shall be installed to assist in running circulating water in the cooling tower. For details, please consult Tyacht.

2. Considerations for Equipment Storage before Installation

When the product is stored before installation, don't cover the unit with oil cloth or other coverings because the unit will be too hot to damage PVC water eliminator and cooling tower fillers. When the product is stored for a long time, the fan and fan shafts shall be rotated regularly and all the bearings shall be lubricated. Clean the bearings and add lubricating grease during test run.

3. Considerations for Installation of Steel Structure Foundation

For the unit with width B greater than 7.3m, three I-shaped steel beams with sufficient length shall be used as the base and steel beams shall be used for fastening the lower surface of the bottom flange outside the unit. The bottom flange of the unit has mounting hole with diameter of 19mm which is used for fastening bolts with I-shaped steel beams (for details, please refer to the exact position of bolt hole provided in the formal drawing). The size of I-shaped steel shall be determined based on engineering experience, the maximum deflection of I-shaped steel is 1/360 of unit length and can't be greater than 13mm, and the deflection of I-shaped steel can be calculated based on 55% operating weight as uniformly distributed load (for operating weight, please refer to the drawing). I-shaped steel shall be leveled before the unit is laid and spacers can't be filled between the flange in the water disc section and I-shaped steel for leveling; otherwise, good longitudinal bracing can't be obtained. I-shaped steel and foundation bolts are provided by other manufacturers. For weight, size and technical data of unit, please refer to Unit Outline Drawing.

4. Considerations for Start, Run and Stop

The following table lists the recommended maintenance work and period during start, run and stop. The maintenance work required for each item shall follow the steps stipulated in the "maintenance procedure" of this manual.

Table 1 Recommended Maintenance Work of Closed Cooling Tower

Maintenance Work Items	Monthly	Quarterly	Start	Stop
Check the general conditions of the cooling tower	★		★	★
If necessary, check and clean:				
(1) Inlet filter			★	★
(2) Cold water basin/filter	★		★	★
(3) Inlet air guide plate	★		★	★
(4) Coiler	★		★	★
Check and adjust the level of water disc	★		★	
Check the running of water inlet valve	★		★	
Check and adjust drainage rate	★		★	
Check the state and tension of driving belt	★		★	
Lubricate fan bearings		★	★	★
Lubricate motor base and adjust screws		★	★	★
Clean the surface of fan motor		★	★	★

Notes:

- 1) Cooling tower shall be maintained generally, but it shall be maintained more frequently in the adverse environmental conditions.
- 2) When cooling tower is operated in the environment temperature which is lower than freezing point, it shall be checked more frequently (refer to “run in winter”).
- 3) The tension of new driving belt shall be readjusted after being operated for initial 24 and in the following each quarter.

Warning:

Cut off all the power and lock it in the off position before maintenance check.

5. Initial and Seasonal Start

The Cooling tower shall be thoroughly checked and cleaned before initial start or after stop period:

- 1) Eliminate all of disintegrating slag, leaves and dust in the tower and inlet guide plate;

- 2) Remove the outlet filter and reinstall it after cleaning;
 - 3) Drain cold water basin (water disc filter in place) and wash cold water basin to remove the accumulated dust and sundries;
 - 4) Remove water disc filter and reinstall it after cleaning;
 - 5) Rotate fan by hands to ensure no jam;
 - 6) Start fan motor and check whether fan rotates accurately;
 - 7) During seasonal start, adjust the tension of driving belt in the fan drive;
 - 8) Check the water inlet valve controlled by floating ball to ensure the valve can move freely;
 - 9) Before seasonal start, lubricate fan bearings;
 - 10) Inject water into cold water basin to reach the overflow water level;
- A. When the cooling tower is started initially or is restarted after cold water basin is drained, the initial creatures shall be killed. (Refer to "water treatment")
- B. After stop period, when water in the cold water basin hasn't been drained completely, creatures shall be killed . appropriately with high strength to clear the accumulative creature residues
- 11) Set the floating ball in the water inlet valve: When the floating ball is about 1.5cm lower than overflow level, the valve is closed;
 - 12) Start circulating water pump and adjust water flow of circulating water system according to design value;
 - 13) Open the valve in the water drain pipe (provided by other manufacturers) and adjust the drainage quantity to the recommended flow; (refer to "water treatment")
 - 14) Check three-phase voltage and current of fan motor and the current can't exceed the numerical value in the nameplate.

After long-term stop, high resistance insulation testing meter shall be used to check the insulating property of motor before starting motor.

Note:

The frequent start-stop cycle may lead to motor overheating. It shall be specified in the control section that the product can be started and stopped for at most six times per hour.

After running with load for 24h, the following work shall be performed:

- 1) Check whether cooling tower has abnormal noise or vibration;
- 2) Check the operating water level of cold water basin and if necessary, adjust water inlet valve;
- 3) Readjust the tension of driving belt;
- 4) Clear inlet filter;
- 5) Confirm that terminals in the water pump motor terminal box have been locked and fastened according to national standards/specifications to avoid short circuit due to virtual connection of terminals.

6. Seasonal Stop

When the cooling tower has to stop for a long time, the following work shall be done:

- 1) Drain water in the cold water basin and in the pipeline which is exposed below freezing point temperature;
- 2) Clear the inlet filter;
- 3) Wash cold water basin when cold water basin filter is in place and open the water outlet of cold water basin to let rainwater and melted snow water flow out of cooling tower;
- 4) Clear cold water basin filter and reinstall it;
- 5) Cover air outlet of fan to block dust and sundries;
- 6) Lubricate fan bearings and regulating screws in the motor base;
- 7) Close stop valve (provided by other manufacturers) in the water supplement pipeline and drain all of exposed water supplement pipelines;
- 8) Check the completeness of corrosion prevention device of steel parts of the cooling tower.

7. Maintenance Procedures

1) Cold water basin and filter

Check the cold water basin regularly to clear sundries which are accumulated in the basin or filter. If necessary, adjust the floating ball to keep the set operating water level. Drain the whole cold water basin quarterly or where necessary and wash down the sludge and sediments which are accumulated in the cold water basin and filler surface during running. If these sediments aren't cleaned regularly, they will be corrosive and thus destroy the protective layer. When the cold water basin is washed, the filter will be in place to prevent sediments enter into cooling tower system again. After the cold water basin is washed, the filter shall be removed and then installed before water is injected into the cold water basin again.

2) Water inlet valve

Check the water inlet valve monthly and adjust it if necessary. Check whether the valve leaks every year and where necessary, replace valve seat. To operate properly, the water supply pressure of water inlet valve shall remain between 1.0-3.5bar. When water level of cold water basin is set initially, adjust butterfly nut so that water level in the cold water basin is 1.5cm lower than overflow tube and water inlet valve can be closed completely. When thermal load and common city water pressure (1.0-3.5bar) are designed, the set value of operating water level (calculated from the bottom of cold water basin) is given in Table 2.

Note:

If the thermal load is lower than the design load during start, the operating water level will be greater than the proposed value. The floating ball of water inlet valve shall be adjusted to obtain the proposed operating water level. Monitor cold water basin closely during running for the initial 24h and where necessary, adjust water level.

Note:

If the thermal load is lower than the design load during start, the operating water level will be greater than the proposed value. The floating ball of water inlet valve shall be adjusted to obtain the proposed operating water level. Monitor cold water basin closely during running for the initial 24h and where necessary, adjust water level.

Table 2 Operating Water Level

Model of Cooling Tower	Height of Water Level of Cold Water Basin
All the models of closed cooling towers	Adjust according to the actual conditions Recommend 15CM

3) Motor

The standard motor which is used by closed cooling towers is TEAO totally enclosed motor and has permanently lubricated ball bearings. Bearings, shafts and coils have special moisture protection. The only one maintenance work which shall be completed during operation is to clean motor surface at least once a quarter so as to ensure motor is cooled. After long-term stop, check the insulating property of motor before start.

4) Fan bearing

A fan shaft is supported by two ball bearings and each one is equipped with lubricating device and clamping ring to guard against damp. Please follow the following instructions to lubricate the bearings:

Initial start: If the cooling tower is placed in the construction site for more than a year, new grease shall be injected into bearings before initial running.

Seasonal start: New grease shall be injected into bearings before start.

Running period: Bearings shall be lubricated every 2000 working hours or every three months, whichever occurs earlier.

Seasonal stop:

New grease shall be injected into bearings before long-term storage or stop.

Note: The Fan bearings can only be lubricated by handheld grease gun rather than high pressure lubricating oil gun which may cause the fracture and damage of bearing seal.

When ambient temperature is between -54 °C -120 °C , the following water-sealed bearing solid lubrication bearings can only be used.

- American -Rycon #3
- Keystone -84EP Light
- Shell -Aeroshell #17
- Chevron -SRI

5) Adjustable motor seat

Regulating screw of motor seat shall be lubricated by high quality grease twice a year (for example, the grease recommended by the above lubrication fan bearings).

Initial start: Adjust the tension and straightness of driving belt;

Run: After driving belt runs initially or new driving belt is installed, the tension shall be adjusted after running for 24h. The tension shall be checked monthly, it shall be adjusted if necessary and the adjustment shall be made at least once every three months.

Seasonal start: Readjust the tension of driving belt.

Note:

When the tension of driving belt is checked, a ruler is placed along the driving belt to span the two belt wheels and is used to measure the deflection of the driving belt. A moderate force (about 18Kg) is evenly applied by hands in the span middle of two belt wheels along the whole width of driving belt and if the deflection scope of driving belt is between 6.5mm-9.5mm, the driving belt has been tensioned fully.

To obtain the maximum service life of the driving belt, the straightness of driving belt shall be checked annually. When the driving in standard form and the driving of energy-saving fan system are checked, a ruler shall be placed to span the driving and driven pulleys. When the straightness of driving belt has been adjusted accurately, the ruler will touch all of four points and the proposed deviation between the ruler and four points shall not be greater than 1.6mm. If necessary, the straightness shall be adjusted. Loosen motor pulley and adjust the straightness based on fan pulley.

8. Considerations for Running in Winter

As heat-sinking capability of cooling tower is designed and selected based on the hottest weather in summer, it is obviously too much in other seasons, especially in winter. Outlet water temperature of the cooling tower has little to do with environment temperature and is mainly affected by wet bulb temperature. However, wet bulb temperature is much lower than environment temperature. Although environment temperature is above zero degree when the cooling tower runs, the cooling tower can reduce water in the tube to below zero and even freeze. If internal and external circulating water in the cooling tower freezes, tubing, heat sink copper tube and other parts in the cooling tower may be damaged. To prevent such accidents, it is particularly important to prevent frostbite in winter.

To avoid the freezing of coiler in the cooling tower due to misoperation so that the normal production is affected, methods for antifreezing in winter are provided below for reference.

I. Antifreezing of external circulation

1) The water electric heater which is used for preventing the freezing of bottom water channel shall be installed. When electric heater is installed, water level switch, temperature controller and other auxiliary equipment are recommended for installation together. In addition, automatic control shall be equipped to prevent dry boiling or overheating of electric heater. However, the heater of water basin can't prevent the freezing of water pipe, water pump and water pump channel outside water basin.

2) External circulating lines (connecting to spray water pump) which are exposed to the outside of bottom water channel, including all of water supply and drainage pipes, pump tubing and overflow fitting shall be wrapped by electric hotlines to keep warm and prevent freezing.

3) During prolonged stop, drain all of external circulating water and keep the drain valves of bottom water channel and apron pump open when being placed.

II. Antifreezing of internal circulation (inside heat-transferring coil)

1) Antifreezing solution shall be added. Industrial ethylene glycol is recommended, but you shall consider whether the corollary equipment allows this substance. The proportion shall be mixed with proper concentration according to local air temperature. As ethylene glycol water solution has low freezing point and high solubility in water, ethylene glycol is a good antifreezing agent. However, deficiencies of the method are that as ethylene glycol solution concentration increases, the performance of cooling tower may degrades slightly. Drain ethylene glycol in summer and use clean water.

2) Antifreezing device in the tube. An auxiliary load shall be kept in the coiler at any time so that when cooling tower stops, water temperature can't reduce to below 10 degrees. For the regular day-running and night-down, bypass electric heater can be installed in the tube. During stop, bypass electric heater can provide heat for heat-sink copper pipe to prevent its freezing. In addition, minimum water recirculation rate shall be kept in the coiler, it's shown in the table below.

Table 3 Recommended minimum water recirculation rate

Model	Minimum Discharge
TMC	M3/Hr
TMC-120~TMC-155	17
TMC-181~TMC-428	25

3) Equipment shall be added in the above-mentioned two methods. If you don't expect to add equipment, you can drain circulating water in the radiating tube during long-term stop in winter. If dewatering outlet isn't set in the user's pipeline, but it is designed in our cooling tower, please open vent valves of cooling tower at the same time when drawing off the water. If there is a condition, high pressure air is used to drive out the circulating water in the tube. Keep the vent valve and drain valve open when being placed. The antifreezing method can only be used in a state of emergency and water in the coiler shall be drained as soon as possible.

4) Other possible energy regulation methods include the adoption of two-speed motor, variable frequency drive and stop/start fan.

The above antifreezing methods can be used separately or can be used in several when the system is designed. For more information about antifreezing method, please directly contact our After-Sale Department and we will be fully committed to serve you.

Note:

The frequent start-stop cycle may lead to motor overheating. The settings in the control section shall be at most six times per hour for start and stop.

If the cooling tower is equipped with double speed motor, double speed motor can run in low speed to prevent freezing.

Note:

When double speed motor is used, the starting device of motor shall include a 15s's delay when it switches from high speed to low speed.

The periodical start-stop of fan is very necessary for preventing freezing or ice accumulated in the guide plate and filler surface due to melted water.

In bad conditions, the periodical interruption can't prevent freezing, so it is necessary to rotate fan inversely so that hot wind blows over air inlet guide plate to remove the accumulated ice and snow.

Note:

Don't rotate the fan inversely longer than necessary because it will lead to the freezing of fan blades, air duct or fan guard and damage the cooling tower. Because of this possibility, cooling tower which rotates fan to remove ice shall be equipped with vibration isolation switch. The fan shall be rotated inversely for at most 30min and about 40s's delay between positive rotation and inverse rotation shall be set in the motor control.

Considerations for places where electric heater is used:

1) Thermostat shall be installed in the places where electric heater is used so that water temperature can't rise to extra-high temperature;

2) To avoid dry heating, please confirm whether heating part of electric heater is dipped in water and then power on. Water level alarm or detector switch is recommended;

3) For other methods of using electric heater, please refer to Operating Manual On Electric Heater which Prevents Cooling Tower from Freezing.

Considerations for places where antifreezing solution is used:

- 1) Depending on the variety and concentration of antifreezing solution, the performance of cooling tower may change, so please note when selecting antifreezing solution.
- 2) The concentration of antifreezing solution may be reduced due to water leakage, so please check the concentration regularly and supplement it where necessary.

Safety considerations

Safety precaution

The cooling tower can only be operated, maintained and repaired by qualified persons who are required to know well the related systems and control of the cooling tower and procedures in this manual. To prevent personal injury or property loss, the right tools and steps shall be used to transport, hoist, install, operate, maintain and repair the equipment.

Note:

All the electric equipment, machinery and rotating machines have potential danger, particularly for those persons who aren't familiar with their design, manufacturing and operation. Therefore, cooling tower shall be protected adequately (the protective cover shall be used where necessary) to prevent the injury of persons (including juveniles) and the damage of the related equipment systems and house. When closed cooling towers are designed, all the routine maintenance has been considered to be completed inside cooling tower or outside unit and can't be done on the top of cooling tower. Don't operate cooling tower until all of fan guard, access plate and access door return to the original position. When fan speed of closed cooling towers is changed by the factory setting rotating speed. For example, the factory uses variable speed control device to change the rotating speed, measures shall be taken to avoid running near "critical speed of rotation" otherwise, the fan will break down and the damage or injury may happen.

To protect maintenance personnel, motors of all the fans and water pumps relating to the cooling tower shall be equipped with switches locked in the off position and these switches shall be located in the visible scope of cooling tower.

Warning:

If you cannot ensure that motors of the fan and water pump have been disconnected and are locked in the off position, don't perform any service operations near fan motor and driving device or inside unit. Chemical or biological contaminants may be included in circulating water system and if they are absorbed, they will lead to the damage. Those persons who are exposed in the vent gas of fan or drifting airflow, or high pressure water

and wet gas generated by compressed air (used for cleaning water circulation system) shall wear the respiratory protection equipment approved by local labor protection department.

9. Considerations for Servicing

Don't enter the cooling tower and climb the cooling tower unless the cooling tower is serviced.

More than two professionals are required to service the cooling tower to avoid accidents.

Make sure that the pressure fan, water pump, electric heater and other power sources of the cooling tower have been disconnected during servicing.

Antifreezing electric heater continues to heat after being disconnected for a period of time, so don't touch it.

Don't enter the cooling tower and climb the cooling tower when the fan runs.

Don't put hands and goods into the fan when the fan runs.

Please maintain body balance when climbing the cooling tower.

Professionals are required to assemble electric wires. Be careful of electric shock and electric leakage.

Please be sure to confirm power capacity, switch and distributor capacity.

Connect wires from ground wires when assembling electric wires.

Please don't lead to electric leakage and short circuit when assembling electric wires.

Please check after assembling electric wires.

Please remove the cooling tower by qualified professionals or experienced persons.

Please don't drink cooling water and absorb droplets when servicing the cooling tower. Please rinse the mouth and wash hands after servicing.

10. External Circulating Water System Maintenance

Pollution discharge:

With the evaporation of water, water equivalent to evaporated water shall be discharged to prevent the blocking of water distribution system by sundries and the accumulation of sundries. A water pump is installed in the side of tower body and is equipped with blow-down pipe and blow-down valve which shall be opened fully to discharge a right amount of water. If there are fewer sundries in the supplemental water, the discharge can be reduced, but the unit shall be checked regularly to ensure there is no dirt and water quality remains chemical equilibrium.

Water treatment:

For closed cooling tower, distributed water directly contacts outside air to increase the calcium and ionic concentration, so the sprinkler system outside the pipe shall be managed. Based on water quality criteria and management method, the data recorded below is the recommended standard values for only reference and can be adjusted according to the actual situations.

Table 4 Recommended indexes of water quality*

Parameters	Range
PH**	6.5 - 9.0*
Hardness (CaCO ₃)	50 -300 ppm
Total alkalinity (CaCO ₃)	50 -300 ppm
Total dissolved solids	<1000 ppm
Total suspended solids	<25 ppm
Bacterial count	<10000 cfu/ml
Chlorine ion content (CL ⁻)	200 ppm galvanized steel
Chlorine ion content (CL ⁻)	400 ppm No. 304 stainless steel
Chlorine ion content (CL ⁻)	4000 ppm No. 316 stainless steel

When PH of circulating water of galvanized steel unit is higher than 8 or higher, to prevent “white rust”, galvanized steelwork component shall be passivated. Water system can't be softened. The acid shall be avoided and if the acid is required for cleaning, the acid with corrosion inhibitor which is available for galvanized steel is only recommended.

The concentration coefficient is controlled by drainage rate and the drainage refers to a small part of water drained from circulating water. Continuous drainage rate can be calculated by the following formula:

$$\text{Drainage rate} = \text{evaporation rate} / (\text{concentration coefficient} - 1)$$

The evaporation rate can be determined by the following methods:

- 1) Evaporation rate: 29L/M per 1163kw of heat dissipating capacity;
- 2) Evaporation rate: 11.5L/M per 100 standard tons of refrigerating capacity;
- 3) Evaporation rate (L/M) = water recirculation rate (T/Hr) X temperature difference (°C) X 0.03

Warning:

Don't add chemical agents in batch and control the addition of chemical agents.

Pressurized water distribution system

Water distribution system shall be checked monthly to ensure its normal operation. The spraying system shall be checked when the water pump is started and the fan is closed. For induced draft unit (except direct drive), some water eliminators near access door shall be installed with the handle so that water eliminators can be removed easily outside the unit to observe water distribution system. For all kinds of models, water spray system can be checked by starting water pump and stopping fan. Water spray nozzle can't be blocked actually, so it is hardly cleaned and maintained.

If water spray nozzle doesn't work well, it means that the filter in the water basin doesn't work and water distribution pipe is accumulated by dirt or sundries. Disconnect the cooling load, start water pump and take out the sundries by moving a small point probe in the spray hole back and forth.

When dirt or sundries are accumulated seriously, the last two water spray nozzles in each piece of branch pipe can be removed and sundries shall be washed into water basin. Branch pipe or connecting pipe can only be removed for cleaning where necessary. Check the filter in the water basin, make sure that it is in a good state and place it accurately so as not to generate cavitation and wrap it into the air.

Operation of chemical dosing and softened water equipment

Each station shall determine the dosing and reagent combination, frequency and dosage of softening and chemical dosing equipment of external circulating water according to its own water quality. Softened water and chemical dosing equipment shall follow equipment manual. Salt for softened water system regularly as the circumstances may require and maintain salt in the salt box.

Adjust the regeneration period of softened water equipment timely according to the change of supplemental water rate and detect the hardness of softened water secretly within three days after each adjustment so as to assure the conformity.

The quality of external circulating water shall be tested once every two months and test items include residual chlorine, total hardness, pH value and turbidity. If the hardness exceeds standard, drain away water by pollution discharge or overflowing to reach the qualified hardness.

Internal circulating water shall be tested every half year and test items include total hardness, pH value and turbidity. In case of abnormal parameters, analyze them timely and take measures.

Switch over the cooling tower at least semimonthly and clean the water tank of the cooling tower. Clean water diffusion hole of water diffusion channel above the cooling tower timely as the circumstances may require.

When switching over the cooling tower and cleaning water tank, pay attention to deposit corrosion of copper pipe and in case of abnormalities, handle it timely.

上海廷亚冷却系统有限公司

Shanghai Tyacht Cooling System Co.,Ltd

总部：上海市鞍山路5号杨浦商城16B-2室（200092）

电话：(+86 21) 5596 0752

传真：(+86 21) 6504 5049

邮箱：tyacht@tyacht.com.cn

网址：www.tyacht.com.cn

厂址：上海市奉贤区柘林镇新寺新林路1529号（201416）

电话：(+86 21) 5789 1990

传真：(+86 21) 5789 1348

Head Office: Room16B-2, No.5 Anshan Road, Shanghai(200092)

Tel: (+86 21) 5596 0752

Fax: (+86 21) 6504 5049

E-mail:tyacht@tyacht.com.cn

Web: www.tyacht.com.cn

Add: No.1529, Xinlin Road, Xinsi, Zhelin Town Fengxian District, Shanghai(201416)

Tel: (+86 21) 5789 1990

Fax: (+86 21) 5789 1348

24小时全国统一服务热线：400-600-0955

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