

OPTION CHECKLIST NO. 8: BOILERS & THERMIC FLUID HEATERS

Periodic tasks and checks outside of the boiler

<ul style="list-style-type: none">• All access doors and plate work should be maintained air tight with effective gaskets.
<ul style="list-style-type: none">• Flue systems should have all joints sealed effectively and be insulated where appropriate.
<ul style="list-style-type: none">• Boiler shells and sections should be effectively insulated. Is existing insulation adequate? If insulation was applied to boilers, pipes and hot water cylinders several years ago, it is almost certainly too thin even if it appears in good condition. Remember, it was installed when fuel costs were much lower. Increased thickness may well be justified.
<ul style="list-style-type: none">• At the end of the heating season, boilers should be sealed thoroughly, internal surfaces either ventilated naturally during the summer or very thoroughly sealed with tray of desiccant inserted. (Only applicable to boilers that will stand idle between heating seasons).

Boilers: extra items for steam raising and hot water boilers

<ul style="list-style-type: none">• Check regularly for build-up of scale or sludge in the boiler vessel or check TDS of boiler water each shift, but not less than once per day. Impurities in boiler water are concentrated in the boiler and the concentration has limits that depend on type of boiler and load. Boiler blow down should be minimized, but consistent with maintaining correct water density. Recover heat from blow down water.
<ul style="list-style-type: none">• With steam boilers, is water treatment adequate to prevent foaming or priming and consequent excessive carry over of water and chemicals into the steam system?
<ul style="list-style-type: none">• For steam boilers: are automatic water level controllers operational? The presence of inter-connecting pipes can be extremely dangerous.
<ul style="list-style-type: none">• Have checks been made regularly on air leakages round boiler inspection doors, or between boiler and chimney? The former can reduce efficiency; the latter can reduce draught availability and may encourage condensation, corrosion and smutting.
<ul style="list-style-type: none">• Combustion conditions should be checked using flue gas analyzers at least twice per season and the fuel/air ratio should be adjusted if required.
<ul style="list-style-type: none">• Both detection and actual controls should be labeled effectively and checked regularly.
<ul style="list-style-type: none">• Safety lockout features should have manual re-set and alarm features.
<ul style="list-style-type: none">• Test points should be available, or permanent indicators should be fitted to oil burners to give operating pressure/temperature conditions.
<ul style="list-style-type: none">• With oil-fired or gas-fired boilers, if cables of fusible link systems for shutdown due to fire or overheating run across any passageway accessible to personnel, they should be fitted above head level.
<ul style="list-style-type: none">• The emergency shut down facility is to be situated at the exit door of the boiler house.

<ul style="list-style-type: none"> • In order to reduce corrosion, steps should be taken to minimize the periods when water return temperatures fall below dew point, particularly on oil and coal fired boilers.
<ul style="list-style-type: none"> • Very large fuel users may have their own weighbridge and so can operate a direct check on deliveries. If no weighbridge exists, occasionally ask your supplier to run via a public weighbridge (or a friendly neighbour with a weighbridge) just as a check? With liquid fuel deliveries check the vehicle's dipsticks?
<ul style="list-style-type: none"> • With boiler plant, ensure that the fuel used is correct for the job. With solid fuel, correct grading or size is important, and ash and moisture content should be as the plant designer originally intended. With oil fuel, ensure that viscosity is correct at the burner, and check the fuel oil temperature.
<ul style="list-style-type: none"> • The monitoring of fuel usage should be as accurate as possible. Fuel stock measurements must be realistic.
<ul style="list-style-type: none"> • With oil burners, examine parts and repairs. Burner nozzles should be changed regularly and cleaned carefully to prevent damage to burner tip.
<ul style="list-style-type: none"> • Maintenance and repair procedures should be reviewed especially for burner equipment, controls and monitoring equipment.
<ul style="list-style-type: none"> • Regular cleaning of heat transfer surfaces maintains efficiency at the highest possible level.
<ul style="list-style-type: none"> • Ensure that the boiler operators are conversant with the operational procedures, especially any new control equipment.
<ul style="list-style-type: none"> • Have you investigated the possibility of heat recovery from boiler exit gases? Modern heat exchangers/recuperators are available for most types and sizes of boiler.
<ul style="list-style-type: none"> • Do you check feed and header tanks for leaking make up valves, correct insulation or loss of water to drain?
<ul style="list-style-type: none"> • The boiler plant may have originally been provided with insulation by the manufacturer. Is this still adequate with today's fuel costs? Check on optimum thickness.
<ul style="list-style-type: none"> • If the amount of steam produced is quite large, invest in a steam meter.
<ul style="list-style-type: none"> • Measure the output of steam and input of fuel. The ratio of steam to fuel is the main measure of efficiency at the boiler.
<ul style="list-style-type: none"> • Use the monitoring system provided: this will expose any signs of deterioration.
<ul style="list-style-type: none"> • Feed water should be checked regularly for both quantity and purity.
<ul style="list-style-type: none"> • Steam meters should be checked occasionally as they deteriorate with time due to erosion of the metering orifice or pilot head. It should be noted that steam meters only give correct readings at the calibrated steam pressure. Recalibration may be required.
<ul style="list-style-type: none"> • Check all pipe work, connectors and steam traps for leaks, even in inaccessible spaces.
<ul style="list-style-type: none"> • Pipes not in use should be isolated and redundant pipes disconnected.
<ul style="list-style-type: none"> • Is someone designated to operate and generally look after the installation? This work should be included in their job specification.

<ul style="list-style-type: none"> • Are basic records available to that person in the form of drawings, operational instructions and maintenance details?
<ul style="list-style-type: none"> • Is a log book kept to record details of maintenance carried out, actual combustion flue gas readings taken, fuel consumption at weekly or monthly intervals, and complaints made?
<ul style="list-style-type: none"> • Ensure that steam pressure is no higher than need be for the job. When night load is materially less than day load, consider a pressure switch to allow pressure to vary over a much wider band during night to reduce frequency of burner cut-out, or limit the maximum firing rate of the burner.
<ul style="list-style-type: none"> • Examine the need for maintaining boilers in standby conditions—this is often an unjustified loss of heat. Standing boilers should be isolated on the fluid and gas sides.
<ul style="list-style-type: none"> • Keep a proper log of boiler house activity so that performance can be measured against targets. When checking combustion, etc. with portable instruments, ensure that this is done regularly and that load conditions are reported in the log: percentage of CO₂ at full flame/half load, etc.
<ul style="list-style-type: none"> • Have the plant checked to ensure that severe load fluctuations are not caused by incorrect operation of auxiliaries in the boiler house, for example, ON/OFF feed control, defective modulating feed systems or incorrect header design.
<ul style="list-style-type: none"> • Have hot water heating systems been dosed with an anti-corrosion additive and is this checked annually to see that concentration is still adequate? Make sure that this additive is NOT put into the domestic hot water heater tank, it will contaminate water going to taps at sinks and basins.
<ul style="list-style-type: none"> • Recover all condensate where practical and substantial savings are possible.

Boiler rooms and plant rooms

<ul style="list-style-type: none"> • Ventilation openings should be kept free and clear at all times and the opening area should be checked to ensure this is adequate.
<ul style="list-style-type: none"> • Plant rooms should not be used for storage, airing or drying purposes.
<ul style="list-style-type: none"> • Is maintenance of pumps and automatic valves in accordance with the manufacturers' instructions?
<ul style="list-style-type: none"> • Are run and standby pump units changed over approximately once per month?
<ul style="list-style-type: none"> • Are pump isolating valves provided?
<ul style="list-style-type: none"> • Are pressure/heat test points and/or indicators provided on each side of the pump?
<ul style="list-style-type: none"> • Are pump casings provided with air release facilities?
<ul style="list-style-type: none"> • Are moving parts (e.g. couplings) guarded?
<ul style="list-style-type: none"> • Ensure that accuracy of the instruments is checked regularly.
<ul style="list-style-type: none"> • Visually inspect all pipe work and valves for any leaks.
<ul style="list-style-type: none"> • Check that all safety devices operate efficiently.
<ul style="list-style-type: none"> • Check all electrical contacts to see that they are clean and secure.
<ul style="list-style-type: none"> • Ensure that all instrument covers and safety shields are in place.

<ul style="list-style-type: none"> • Inspect all sensors, make sure they are clean, unobstructed and not exposed to unrepresentative conditions, for example temperature sensors must not be exposed to direct sunlight nor be placed near hot pipes or a process plant.
<ul style="list-style-type: none"> • Ensure that only authorized personnel have access to control equipment.
<ul style="list-style-type: none"> • Each section of the plant should operate when essential, and should preferably be controlled automatically.
<ul style="list-style-type: none"> • Time controls should be incorporated and operation of the whole plant should, preferably, be automatic.
<ul style="list-style-type: none"> • In multiple boiler installations, boilers not required to be available should be isolated on the waterside and—if safe and possible—on the gas side too. Make sure boilers cannot be fired.
<ul style="list-style-type: none"> • Isolation of flue system (with protection) also reduces heat losses.
<ul style="list-style-type: none"> • In multiple boiler installations the lead/lag control should have a change round facility.
<ul style="list-style-type: none"> • Where possible, any reduction in the system operating temperature should be made by devices external to the boiler, the boiler plant operating in a normal constant temperature range.

Water and steam

<ul style="list-style-type: none"> • Water fed into the boilers must meet the specifications given by the manufacturers. The water must be clear, colourless and free from suspended impurities.
<ul style="list-style-type: none"> • Hardness nil. Max. 0.25 ppm CaCO₃.
<ul style="list-style-type: none"> • pH of 8 to 10 retard forward action or corrosion. pH less than 7 speeds up corrosion due to acidic action.
<ul style="list-style-type: none"> • Dissolved O₂ less than 0.02 mg/l. Its presence with SO₂ causes corrosion problems.
<ul style="list-style-type: none"> • CO₂ level should be kept very low. Its presence with O₂ causes corrosion, especially in copper and copper bearing alloys.
<ul style="list-style-type: none"> • Water must be free from oil—it causes priming.

Boiler water

<ul style="list-style-type: none"> • Water must be alkaline—within 150 ppm of CaCO₃ and above 50 ppm of CaCO₃ at pH 8.3.- Alkalinity number should be less than 120.
<ul style="list-style-type: none"> • Total solids should be maintained below the value at which contamination of steam becomes excessive, in order to avoid cooling over and accompanying danger of deposition on super heater, steam mains and prime movers.
<ul style="list-style-type: none"> • Phosphate should be no more than 25 ppm P₂ O₅.
<ul style="list-style-type: none"> • Make up feed water should not contain more than traces of silica. There must be less than 40 ppm in boiler water and 0.02 ppm in steam, as SiO₂. Greater amounts may be carried to turbine blades.

<ul style="list-style-type: none"> • Water treatment plants suitable for the application must be installed to ensure water purity, and a chemical dosing arrangement must be provided to further control boiler water quality. Blow downs should be resorted to when concentration increases beyond the permissible limits stipulated by the manufacturers.
<ul style="list-style-type: none"> • Alkalinity should not exceed 20per cent of total concentration. Boiler water level should be correctly maintained. Normally, 2 gauge glasses are provided to ensure this.
<ul style="list-style-type: none"> • Operators should blow these down regularly in every shift, or at least once per day where boilers are steamed less than 24 hours a day.

Blow down (BD) procedure

<ul style="list-style-type: none"> • A conventional and accepted procedure for blowing down gauge is as follows: Close water lock, Open drain cock (note that steam escapes freely), Close drain cock, Close steam cock, Open water cock, Open drain cock (note that water escapes freely), Close drain cock, Open steam cock, Open and then close drain cock for final blow through.
<ul style="list-style-type: none"> • The water that first appears is generally representative of the boiler water. If it is discolored, the reason should be ascertained.

方案列表8: 锅炉和热流加热器

定期的任务以及锅炉外部检查

<ul style="list-style-type: none">• 锅炉所有的炉门和管板都必须用有效的衬垫维持气密。
<ul style="list-style-type: none">• 气体管道系统所有的接头都必须有效密封，适当的地方还应该进行保温。
<ul style="list-style-type: none">• 锅炉壳体和管段必须进行有效保温。现有的保温措施是否足够了呢？如果锅炉、管道和热水储水罐的保温层是几年前做的，它们肯定已经非常薄了，即使看起来状况还不错。记住，它们都是在燃料成本很低的时候安装的。现在我们有充分的理由加厚保温层。
<ul style="list-style-type: none">• 供暖季节结束后，应该对锅炉进行全面的密封。在夏季，可以对锅炉内表面进行自然通风或插入干燥盘进行彻底密封（仅适用于供暖季节之间停止运行的锅炉）。

锅炉：产生蒸汽和热水的锅炉的额外项目

<ul style="list-style-type: none">• 定期检查锅炉导管内的铁锈或淤渣，或者在每次锅炉轮班时检查锅炉用水的技术数据系统，但至少应每年检查一次。锅炉用水中的杂质会在锅炉中沉淀，但沉淀也有一个限度，取决于锅炉的型号和负荷。锅炉排水应尽量减少，但应和维持正确的水密度保持一致。可从锅炉排放的废水中回收余热。
<ul style="list-style-type: none">• 对于蒸汽锅炉，给水要经过足够的处理，以防止起泡或汽水共腾，并防止连续地将过多的水分和化学物质带入蒸汽系统。
<ul style="list-style-type: none">• 对于蒸汽锅炉：自动水位控制器是否正常运行？存在内部连接的管道是相当危险的。
<ul style="list-style-type: none">• 是否定期检查锅炉探测门周围的、或锅炉与烟囱之间的空气泄漏情况？锅炉探测门周围的空气泄漏会导致效率的降低，锅炉与烟囱之间的空气泄漏会降低通风的有效性，并可能导致烟气浓缩、烟道腐蚀和玷污。
<ul style="list-style-type: none">• 每季至少两次使用烟气分析仪检查燃烧状况，如有需要，则调整烟气/空气比例值。
<ul style="list-style-type: none">• 探测和实际控制装置应有效的分类，并定期进行检查。
<ul style="list-style-type: none">• 安全保护装置应具备可以手工设定和报警的特性。
<ul style="list-style-type: none">• 需要设置测试点，或在油燃烧器上安装永久的监测器，以得到运行时压力/温度的情况。
<ul style="list-style-type: none">• 对于燃油锅炉或燃气锅炉，为了防止喷火或过热气流喷到任何一条人行过道上，熔断连接系统的缆线将被断开，该缆线的安装高度应高于人的高度。
<ul style="list-style-type: none">• 紧急关闭系统应安装在锅炉房的出口上。
<ul style="list-style-type: none">• 为了减少腐蚀，应该采取措施以减少回水温度低于露点温度的周期，特别在燃油和燃煤锅炉上应采取相应的措施。

<ul style="list-style-type: none"> ● 是否需要在液态燃油运输过程中检查油罐车的量油尺？需要大量燃料的使用者可自备一个地秤，这样就可对运来的燃料进行直接的检测称定。若使用者没有自己的地秤，他是否可以不时的要求供货者使用一个公共的地秤称定货物（或使用一个友好邻里的地秤）？
<ul style="list-style-type: none"> ● 对于锅炉厂，需保证燃料用的恰到好处。对于固体燃料来说，恰当的分等级和筛大小是很重要的，并且飞灰和水分含量应和设计者最初的设计值一样。对于油燃料来说，应保证它在 燃烧器处具有恰当的粘性，并检查燃油温度。
<ul style="list-style-type: none"> ● 对燃料使用的检测应尽可能的可靠。燃料库存量的测量必须真实可靠。
<ul style="list-style-type: none"> ● 对于油燃烧器，需检查零件和检修处。燃烧器喷嘴应定期的更换和仔细清洗，以防止燃烧器喷尖受到损伤。
<ul style="list-style-type: none"> ● 应该检查维护和修理的程序，特别是燃烧器设备，控制和监控设备的维护和修理程序。
<ul style="list-style-type: none"> ● 定期清理热交换表面以保持尽可能高的效率。
<ul style="list-style-type: none"> ● 应保证锅炉的操作者对操作的程序相当的熟悉，特别要对任何新的控制设备熟悉。
<ul style="list-style-type: none"> ● 你是否调查过从锅炉出口的烟气中回收热量的可能性？当今的热交换器/换热器对很多型号和大小的锅炉都是实用的。
<ul style="list-style-type: none"> ● 你是否检查过给水箱和联箱的漏水补给阀？更正保温性或损失的排水？
<ul style="list-style-type: none"> ● 制造商可能起初就已经为锅炉厂提供了保温装置。但对于今天的燃料成本来说这样的保温是否就足够了？检查对照最优厚度。
<ul style="list-style-type: none"> ● 如果产生的蒸汽量非常大，则投资安装蒸汽流量计。
<ul style="list-style-type: none"> ● 测量产出的蒸汽量和投入的燃料量，蒸汽量对燃料量的比值是衡量锅炉效率的主要参数。
<ul style="list-style-type: none"> ● 使用提供撒监控系统：它会暴露出任何变坏的征兆。
<ul style="list-style-type: none"> ● 应定期检查给水量和它的纯度。
<ul style="list-style-type: none"> ● 应不时的检查蒸汽流量计，它们的运行状况会随着时间的流逝而变坏，这是因为它们的测量口和指示口会被腐蚀掉。应该注意到蒸汽流量计只有在校准的蒸汽压力下才能显示出正确的读数，有时可能需要对它进行重新校准。
<ul style="list-style-type: none"> ● 检查所有的管道，连接器和疏水器的泄漏情况，即使无法接近的地方也要检查。
<ul style="list-style-type: none"> ● 应将没有使用的管道同其他设备分开，多余的管道应拆卸掉。
<ul style="list-style-type: none"> ● 是否指定某人在设备安装好后负责设备运行和总管？这项工作应包括在他们的具体工作的范围定义中。
<ul style="list-style-type: none"> ● 负责人是否可以得到基本的记录资料诸如图纸，操作说明书和维修细节说明等？
<ul style="list-style-type: none"> ● 是否有一个小本子，用来记录进行维修的详细资料，实际燃烧烟气的读数，每周或每月的燃料消耗量以及各种投诉？
<ul style="list-style-type: none"> ● 确保蒸汽压力不高于工作需要值。当晚上的负荷大大小于白天的负荷时，应考虑使用压力开关，以使得压力在晚上时能在一个更宽的范围值

内变化，从而减少燃烧器断流的频率，或限制燃烧器燃烧速度的最大值。
<ul style="list-style-type: none"> 检查维持锅炉备用状况的需求程度—这是经常未被证实的能量损失。标准锅炉的蒸汽侧和烟气侧应隔离开来。
<ul style="list-style-type: none"> 将在锅炉房实施的工作用备忘录记录下来，这样可以使得执行的效果和既定的目标相比较，如当检查燃烧状况等等。在轻便设备的帮助下，确保检查工作定期的进行，并确保负荷状况已记录在备忘录上：如CO₂在全负荷/半负荷时的含量等。
<ul style="list-style-type: none"> 检查全厂设备，确保不会由锅炉房辅助设备不正常的运行而导致严重的负荷波动，例如，开/关给料控制器，有缺陷的调整给料系统或不正确的联箱设计。
<ul style="list-style-type: none"> 是否在热水加热系统内注入了防腐蚀药剂，是否每年检查这些系统以确定药剂浓度仍足够？要确保这种防腐蚀药剂没有注入民用热水联箱中，否则它将污染通向水池的水。
<ul style="list-style-type: none"> 回收所有的冷凝水，可以节约大量实用的资源成本。

锅炉房和车间

<ul style="list-style-type: none"> 通风口应一直保持空闲和清洁的状况，并且应检查通风口区域是否足够。
<ul style="list-style-type: none"> 车间不能用于储藏、通风和干燥等目的。
<ul style="list-style-type: none"> 泵和自动阀门的维护是否是依照制造商的指导进行的？
<ul style="list-style-type: none"> 运行和备用的泵装置是否大约每月互换一次？
<ul style="list-style-type: none"> 是否安装了泵截止阀？
<ul style="list-style-type: none"> 是否每个泵都配备了压力/热量测试点和/或指示器？
<ul style="list-style-type: none"> 泵体外壳是否有放气装置？
<ul style="list-style-type: none"> 活动部位（如软管接头）是否有保护装置？
<ul style="list-style-type: none"> 确保定期检查设备的精确性。
<ul style="list-style-type: none"> 从视觉上检查所有的管道是否存在泄漏。
<ul style="list-style-type: none"> 确保所有的安全装置能够有效运行。
<ul style="list-style-type: none"> 检查所有的电接触装置，确保它们清洁、安全。
<ul style="list-style-type: none"> 确保所有设备的外罩和安全挡板都到位。
<ul style="list-style-type: none"> 检查所有传感器，确保它们清洁、不受阻碍、不是安装在非典型的环境下，例如，温度传感器就一定不能受阳光直射，或者安放在热管道或加工车间附近。
<ul style="list-style-type: none"> 确保只有经过批准的员工才能操作控制设备。
<ul style="list-style-type: none"> 必要时工厂所有的部分都需要运行，最好采用自动控制。
<ul style="list-style-type: none"> 时间控制也要成为工厂控制的手段之一，而整个工厂的控制最好用自动控制。
<ul style="list-style-type: none"> 在安装多级锅炉时，应将不使用的锅炉的水侧隔离起来—如果安全可行，应将它的烟气侧也隔离起来。以防止锅炉着火。

<ul style="list-style-type: none"> • 隔离烟道系统能有效减少热损失。
<ul style="list-style-type: none"> • 在安装多级锅炉时，在设备周围的引线/外套控制器应有所变化。
<ul style="list-style-type: none"> • 如有可能，任何系统运行温度的降低须经锅炉外部装置进行处理，锅炉厂的运作要保持在一一定的恒温环境。

水和水蒸汽

<ul style="list-style-type: none"> • 注入锅炉的水要符合生产厂商的要求，水质应该干净、无色、没有悬浮的杂质。
<ul style="list-style-type: none"> • 硬度最大不超过0.25 ppm CaCO₃.
<ul style="list-style-type: none"> • 当pH值在8到10之间时，能起到防腐的功能；反之，若pH值小于7时，由于酸的作用，腐蚀速度增加。
<ul style="list-style-type: none"> • O₂的水溶解含量不超过0.02 mg/l，O₂若与SO₂混合将会产生腐蚀效应。
<ul style="list-style-type: none"> • CO₂含量需保持在很低的水平，当它跟O₂混在一起时会产生腐蚀作用，特别是腐蚀铜和铜合金。
<ul style="list-style-type: none"> • 水里不能含有油，否则会引起爆炸。

锅炉给水

<ul style="list-style-type: none"> • 水必须为碱性，CaCO₃的含量应在50 ppm至150ppm之间，pH值为8.3，碱度值应少于120。
<ul style="list-style-type: none"> • 整个固体杂质的数值应低于一定的标准：水蒸气里的污染物不能超标，避免冷却后沉积于过热器，蒸汽主机和初级叶片的危险。
<ul style="list-style-type: none"> • 磷酸盐P₂O₅的浓度不应超25 ppm。
<ul style="list-style-type: none"> • 确保锅炉补给水不应含有太多的硅元素，SiO₂的浓度控制应为：锅炉水里不超过40 ppm；水蒸汽里不超过0.02 ppm。若浓度超标，多余的SiO₂会被附着在汽轮机叶片上。
<ul style="list-style-type: none"> • 必须安装可行的水处理以确保水质的纯净，而化学药剂的使用是为了进一步控制锅炉水质；当水杂质的浓度超标，达不到厂商规定的要求时，可以进行排污。
<ul style="list-style-type: none"> • 碱浓度不应超过总浓度的20%；锅炉汽包里的水位要保持在正确的位置；通常，使用2个玻璃水位计来确保汽包的正确水位。
<ul style="list-style-type: none"> • 操作人员应该在每次换岗时定时进行排放处理，或者当锅炉加热时间一天少于24小时时，至少要进行一次排放处理。

排污步骤

<ul style="list-style-type: none"> • 通常为人们所接受的排污步骤如下：关上水阀，打开排放阀（注意水蒸气此时会自由扩散），关上排放阀，关上蒸气阀，打开水阀，打开排放阀（注意水此时会自由溢出），关上排放阀，打开水蒸气阀，打开然后在关上排放阀以便最终排放。
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- 锅炉废水通常都会先排放出来；若发现水质有杂色，其原因需及时查明。