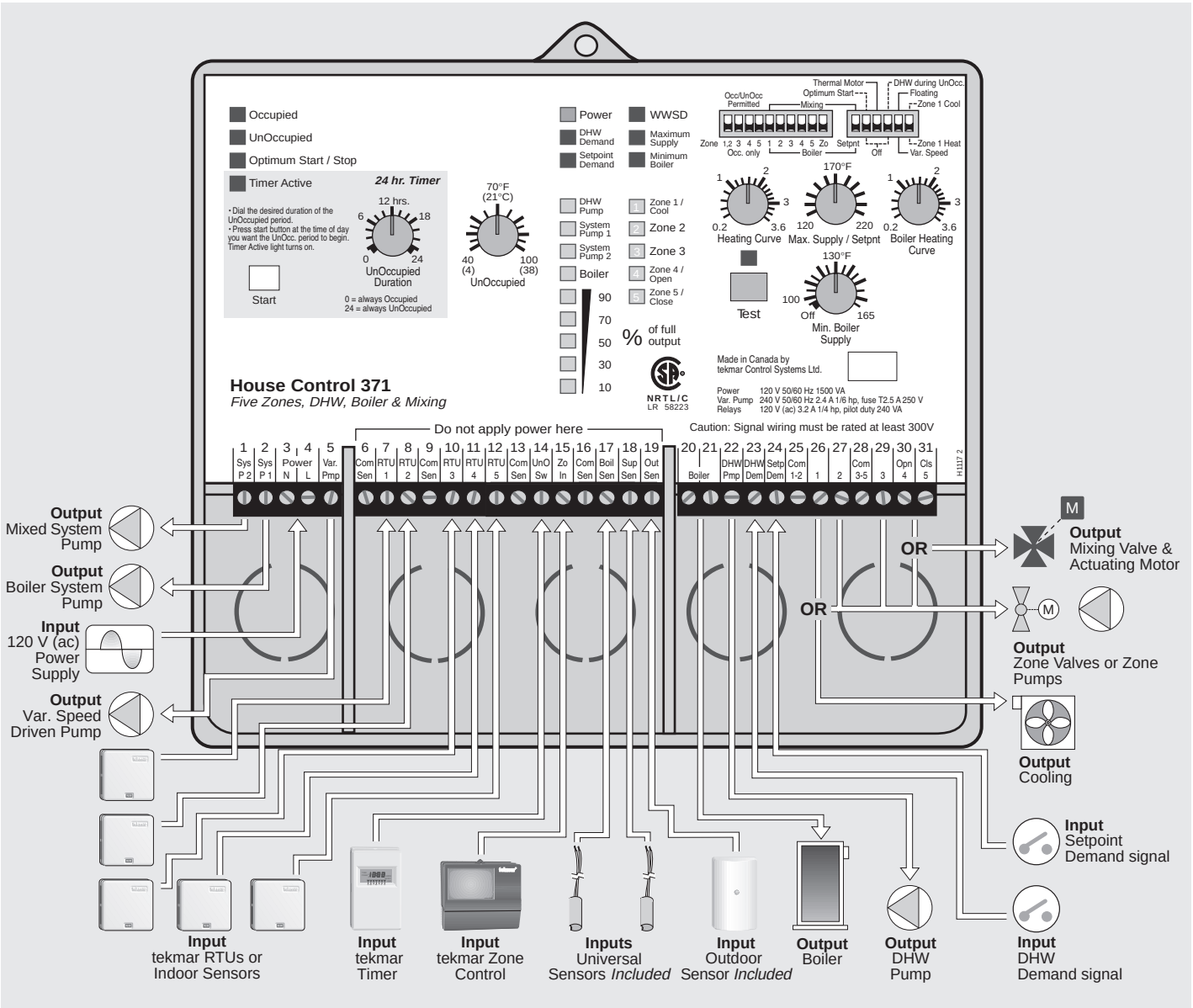
tekmar® - Data Brochure

House Control 371

D 371

07/96

The House Control 371 is a microprocessor-based control that provides individual temperature control for up to 5 zones. Each zone can be either connected to the boiler (hot water) loop or to the mixing (warm water) loop. The supply water temperature to the zones is modulated based on both the outdoor temperature and indoor temperature feedback from each of the zones. This outdoor reset strategy reduces indoor temperature swings and increases system efficiency. Other energy saving functions include a heating system Warm Weather Shut Down (WWSD) and the ability to lower indoor temperatures for a night setback period. The control has an Optimum Start / Stop function which automatically calculates when to bring each zone out of night setback in order to ensure they are returned to their normal operating temperatures as the setback period ends. The 371 allows integration of an indirect fired DHW tank into the system. This helps provide faster DHW tank pick-up times and greater energy savings. The control can also receive a setpoint demand on either the mixing loop or the boiler loop for snow melting, hot tubs, or other loads.

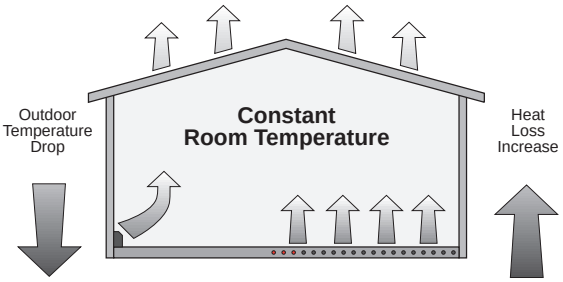


OUTDOOR RESET

In order to properly control a hot water heating system, the heat supplied to the building must equal the heat lost by the building.

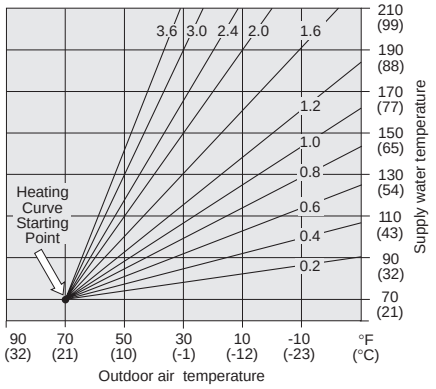
• The heat supplied to a building is proportional to the temperature of the water and the surface area of the heating element. A small surface area such as baseboard radiators requires a higher water temperature than a larger surface area such as radiant floors.

• The heat lost from a building is dependent on the outdoor temperature. As the outdoor temperature drops, the building heat loss increases.



Heating Curve

A hot water heating system can be accurately controlled by modulating the supply water temperature as the outdoor temperature changes. Using this approach, the heat lost from the building is exactly matched by the heat input to the building. A tekmar reset control utilizes a heating curve to set the relationship between outdoor temperature and supply water temperature. The heating curve determines the amount the supply water temperature is raised for every 1° drop in outdoor air temperature. The heating curve is sometimes called an outdoor reset ratio.

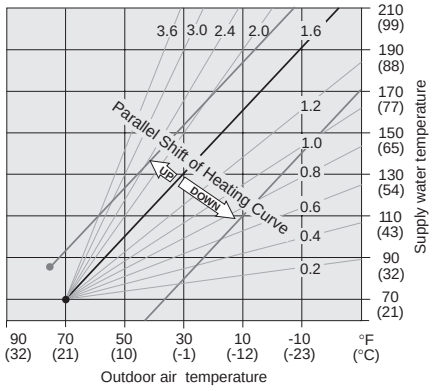


Heating Curve Shift

All heating curves begin at the heating curve starting point. If the heating curve starting point is adjusted, the heating curve will be parallel shifted. The heating curve starting point is either set manually through a dial, or it is determined automatically by the control through indoor temperature feedback.

Indoor Temperature Feedback

Most buildings have internal heat gains due to people, passive solar heating and mechanical or electrical equipment. If only the outdoor temperature is measured, the control cannot compensate for these internal heat gains and the building may overheat. In order to prevent overheating, indoor temperature feedback should be combined with the outdoor reset strategy. From this indoor temperature feedback, the control can change the heating curve starting point in order to match the supply water temperature to the heat loss of the building. If the indoor temperature is too warm, the control automatically shifts the starting point and the heating curve down. If the indoor temperature is too cold, the control shifts the starting point and the heating curve up.



Warm Weather Shut Down (WWSD)

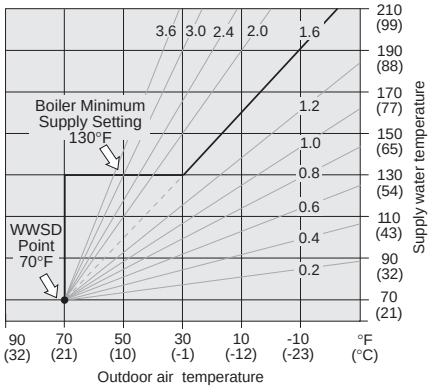
When the outdoor air temperature is equal to the heating curve starting point, no additional heat is required in the building and therefore the heating system can be shut down. The WWSD point is normally the same as the heating curve starting point.

BOILER OPERATION

The supply water temperature from a boiler can be controlled by cycling the boiler on and off. Modulation of the boiler's operating temperature in hot water heating systems not only provides more comfort but also offers significant energy savings. The cooler the boiler runs, the more efficient it is due to less heat losses up the flue and reduced boiler jacket losses.

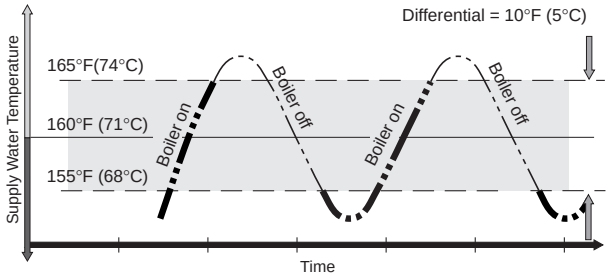
Boiler Minimum Supply

Most boilers require a minimum supply water temperature in order to prevent corrosion from flue gas condensation. The control should therefore only modulate the boiler supply water temperature down to the boiler manufacturer's minimum recommended operating temperature. Some boilers are designed to condense and should be operated at low water temperatures as much as possible for maximum efficiency.



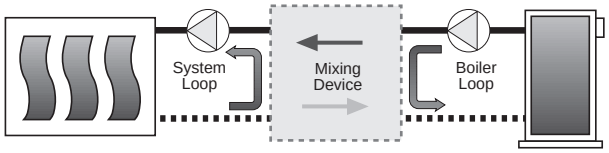
Boiler Differential

An on / off boiler must be operated with a differential in order to prevent short cycling. When the supply water temperature drops below the bottom rail of the differential, the boiler is turned on. The boiler is then kept on until the supply water temperature rises above the top rail of the differential. If the differential is too wide, there can be large supply water temperature swings; however, if the differential is too narrow, the boiler short cycles and operates inefficiently. Some controls automatically calculate the boiler differential in order to achieve an appropriate balance between temperature swings and boiler efficiency. This also permits the control to adapt to changing loads and conditions.



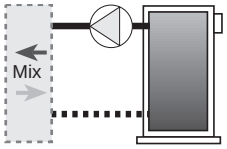
MIXING OPERATION

The full range of water temperatures required through a heating season can be provided with a standard (non-condensing) boiler by incorporating a modulating mixing device into the system. Mixing valves or variable speed injection pumps are commonly used to modulate both the system supply water temperature and the boiler return water temperature. The modulation of water temperatures improves comfort in the building and also protects the boiler from cool return water. For more detailed information on mixing methods consult Essay E 021.



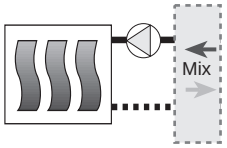
Boiler Protection

Cool water is often returned to the boiler from low temperature radiant floor heating systems or when the heating system is recovering from night setback. This cool boiler return water may cause the boiler to operate at such a low temperature that the flue gases condense. Alternatively, when the boiler surfaces are hot due to previous loads such as domestic hot water generation, the large temperature difference (ΔT) between the boiler and its return water can cause the boiler to become thermally shocked. Proper protection of the boiler under these circumstances requires a modulating mixing device that can temporarily reduce the heating load. This is normally accomplished by closing a valve or reducing the speed of an injection pump.



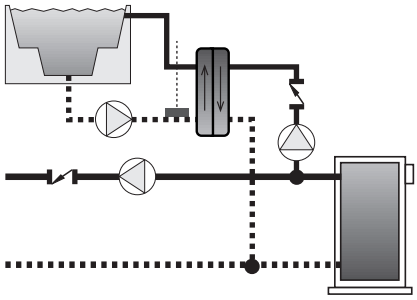
System Maximum Supply

Some systems, such as hydronic radiant floor heating, usually operate at water temperatures that are below the minimum boiler supply temperature. This is due to the large surface area of the floors which radiate a significant amount of heat at low water temperatures. Floor heating systems and flat panel convectors also have a maximum surface temperature limit for occupant health reasons. In such systems a modulating mixing device is normally required to limit the supply water temperature.



SETPOINT OPERATION

Some loads such as spa heating or pool heating require a fixed setpoint water supply temperature. The required setpoint water temperature can be either high temperature or low temperature. When a setpoint demand for high temperature water is present, the control should cycle a boiler on and off to maintain this temperature. For lower water temperature requirements, the control should operate a mixing device. If outdoor reset is used and a setpoint operation is required, the control should override the reset operation and increase the water temperature.



DOMESTIC HOT WATER (DHW)

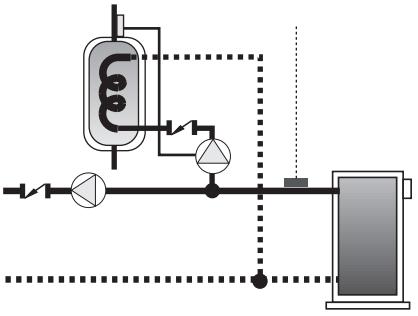
An indirect fired DHW tank can be integrated into the hydronic heating system for greater system efficiency and faster DHW recovery.

DHW Supply

Indirect DHW tanks are typically heated with a boiler water temperature of 180 to 200°F (82 to 93°C). When outdoor reset is used, the boiler supply water may be well below this temperature and therefore an outdoor reset override is required. When the DHW tank calls for heat, the control must turn on the appropriate pump and ensure there is hot boiler supply water.

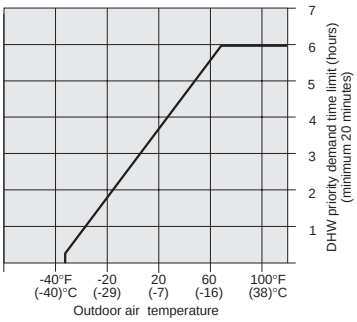
DHW Priority

It is often desirable to temporarily suspend the flow of heat to the heating system when the DHW tank calls for heat. This allows the DHW tank to recover faster than when both the DHW and heating system operate simultaneously. If the heating system has a large thermal mass, a relatively short interruption of the heat supply is not noticed by the occupants. Heating systems with a smaller thermal mass may cool down while the heating system is turned off.



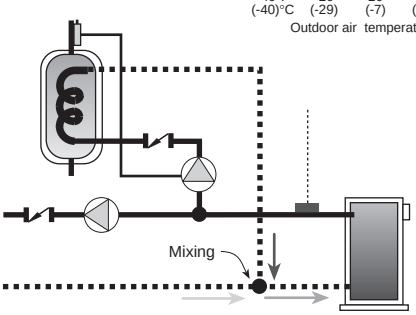
DHW Priority Override

There is always the possibility of an excessively long DHW call for heat due to a broken pipe, faulty aquastat or other problems. At cold outdoor conditions the building may freeze when there is a long DHW draw with DHW Priority selected. In order to prevent this, the control must override the DHW Priority and simultaneously operate the DHW and heating systems. The maximum time allotted for DHW Priority should decrease as the outdoor temperature drops.



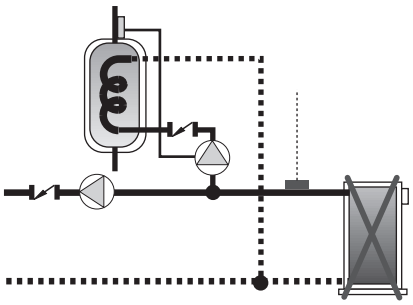
Boiler Shock Protection

When DHW priority is used, the temperature within the heating system terminal unit may be significantly lower than the boiler temperature once the DHW operation is complete. If the DHW pump or valve is simply turned off and the heating system pump turned on, a large ΔT can develop across the boiler. This may induce thermal shock of the boiler. In order to provide a smooth transition between the DHW and heating system loads, the control must simultaneously operate the DHW pump and heating system pump for a short period of time. This mixes the water returning to the boiler and minimizes the possibility of thermal shock.



DHW Post Purge

During the DHW operation, the boiler temperature is normally raised above 180°F (82°C). Once the DHW tank is satisfied, the residual heat within the boiler should be purged in order to reduce stand-by losses. When the heating system does not require heat, the boiler can be purged into the DHW tank. This is accomplished by turning the boiler off but keeping the DHW pump or valve operating for a purging period. If the boiler supply temperature drops below the DHW tank temperature, heat will be removed from the DHW tank. Therefore, the post purge is terminated if the boiler supply is not hot enough. This means that the DHW post purge will not always take the same length of time.



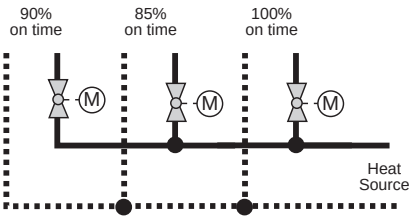
DHW Setback

During the night, or when people are not within the building, energy can be saved by lowering the DHW tank temperature. A lower tank temperature is achieved when the system control ignores the call for heat from the DHW aquastat. In order to prevent a cold DHW temperature at the start of the Occupied period, the system control must raise the tank temperature before the setback period ends.

ZONING OPERATION

In a multiple zone heating system, the zones may have different internal heat gains, heat losses or different temperature settings. Each zone must therefore have individual temperature control. For maximum comfort, the heat should be continuously supplied to the zone at the same rate the zone is losing heat. The most accurate method of accomplishing this is by outdoor reset; however, it is not normally economical to modulate the supply water temperature to every zone.

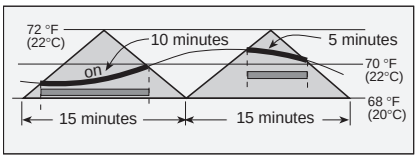
Outdoor reset can be combined with zoning for a more cost effective solution. Through indoor sensors, a zone control can provide indoor temperature feedback to the outdoor reset control. The outdoor reset control will then adjust the supply water temperature to satisfy the zone with the highest water temperature requirement. Heat to the remaining zones will be cycled on and off by the zone control using zone valves or pumps. Since the heat is cycled on and off, accurate PID control logic should be provided to maintain a stable indoor temperature.



PID Zone Temperature Control

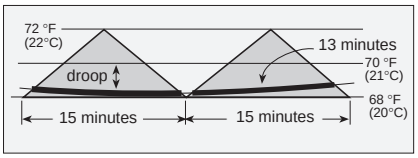
Proportional (P)

In order to prevent indoor temperature swings, the heat supplied to each zone must be proportional to the heat required by the zone. Proportional control logic can be accomplished by pulse width modulation (PWM). A typical PWM system has a fixed operating cycle. During this operating cycle, the on time of the zone relay is varied based on the difference between the desired zone temperature and the actual zone temperature. As the zone temperature drops, the relay on time increases and as the zone temperature rises, the relay on time decreases.



Integral (I)

Controls that are strictly proportional suffer from a problem of offset. The amount of heat supplied to the zone depends on how far the space temperature is below the desired setpoint. This implies that as the heating load increases, the average room temperature droops. On the coldest day of the year, the most heat is required and therefore the room temperature must be coldest.



In order to overcome this offset, integral control logic is used. Only digital controls can provide integral control logic due to the lengthy response time of buildings. Integral control logic is based on time. The longer the room temperature is below the desired setpoint, the more heat is supplied to the room. With integral control logic, full heat can be supplied to the room on the coldest day of the year without requiring that the room be cold.

Derivative (D)

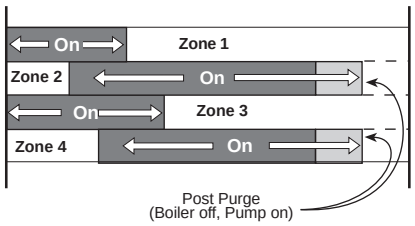
In order to speed up the control's response to quick changes in the heating load, derivative control logic is required. However, sudden room temperature changes, for example from an open door or window, should be ignored by an intelligent control.

P + I + D = PID

If proportional, integral and derivative (PID) control logic are combined, the control is more able to prevent excessive temperature swings and provide a stable room temperature under all conditions. It not only takes into account how much the room temperature has drooped, but also how long there has been a droop and how fast the temperature is changing.

Zone Load Coordination

In a multiple zone system, there can be sudden load changes on the boiler and system due to multiple zones turning on or off. These sudden load changes often lead to boiler short cycling and unnecessary mechanical stresses. The operation of the system can be improved by staggering the starting points of each zone relay within the operating cycle. Staggering of the zones maintains a relatively constant system flow rate which improves boiler operation. Controlled staggering can also minimize boiler running time and improve system efficiency when only a few zones are needed for short periods.



Zone Post Purge

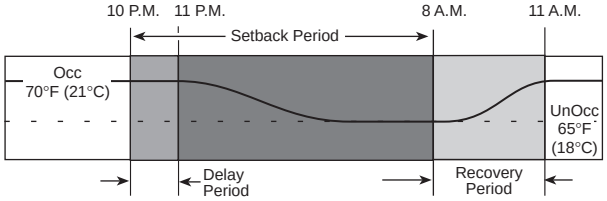
Before the last zone is turned off in a heating cycle, the boiler is turned off but the zone continues to draw heat from the boiler. This post purge of the boiler reduces stand-by losses and reduces overall energy consumption.

UNOCCUPIED (NIGHT SETBACK)

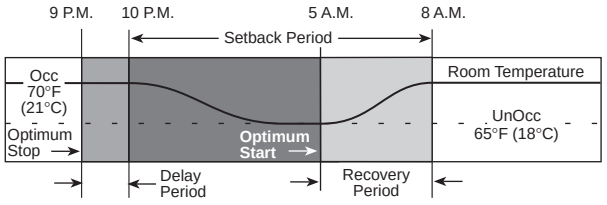
During the night, or at times when people are not within the building, energy can be saved by lowering the building temperature for an UnOccupied (Night Setback) period.

Due to the large thermal mass of buildings, it takes a long time for the indoor space temperature to significantly change whenever the heating system is turned on or off. The building heat up or cool down time is further increased when high mass heating systems are used (e.g. radiant floors). In most cases night setback cannot be used with these systems due to the long recovery time required in the morning. A typical system is demonstrated in the adjacent diagram.

At the start of the night setback period the heat is turned off, but the heat contained within the slab or radiator continues to heat the building and there is a delay before the space temperature begins to drop. At the end of this delay the temperature within the building gradually decreases, and may eventually reach the required UnOccupied temperature after sufficient time has elapsed. Once the setback period is complete, the heat is turned on again but there is a long recovery time required to raise the space temperature to the desired setpoint. The length of the delay and recovery periods changes with outdoor temperature and is different for each zone within the building.

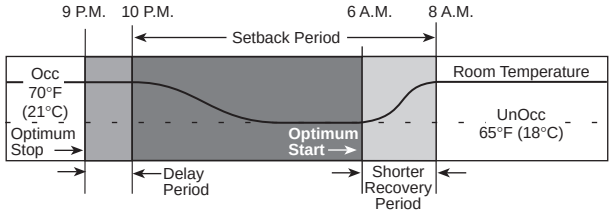


A comfortable setback can be provided if the control "learns" the response time for each zone within the building. Based on the zone's response time, the control can then calculate an Optimum Stop time and an Optimum Start time. At the Optimum Stop time the control turns off the zone valve or pump before the selected UnOcc time in order to overcome the delay period. At the Optimum Start time, the control starts to raise the zone temperature before the selected Occ time in order to overcome the recovery period. This allows night setback to be used with most heating systems.



Optimum Start / Stop with Water Temperature Boost

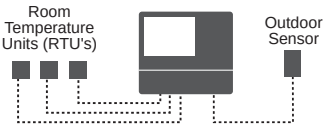
When Optimum Start / Stop is combined with Outdoor Reset, the control can boost the water temperature during the recovery period. This provides a faster recovery and allows a longer setback for greater energy savings.



The accuracy of the Optimum Start / Stop routine depends on the feedback available to the control.

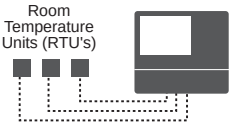
Optimum Start / Stop with both Outdoor and Indoor Sensors

The response time of the building varies with outdoor temperature and is also different for each zone. The most accurate Optimum Start / Stop routine is therefore achieved when both the indoor and outdoor temperatures are monitored during transitions between UnOccupied and Occupied modes.



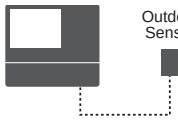
Optimum Start / Stop with only Indoor Sensors

When only indoor temperature feedback is available, the control must base all Optimum Start / Stop calculations on only indoor temperature. If there are large variations in outdoor temperature, this method cannot provide the same level of accuracy as when both indoor and outdoor sensors are used.



Optimum Start / Stop with only an Outdoor Sensor

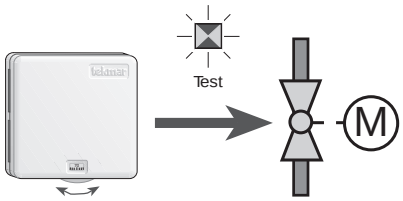
Every building, and often each zone within the building, has a different response time. When only an outdoor sensor is used, the control must assume a particular response time for the entire building. Therefore this is generally the least accurate method of calculating Optimum Start / Stop times.



Sequence of Operation

POWERING UP THE CONTROL

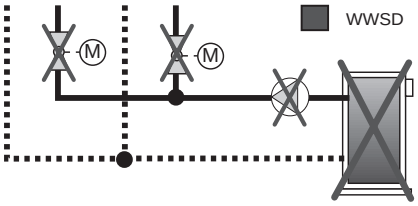
After the House Control 371 is powered up, a software version code is displayed for 2 seconds and then the red indicator lights are turned on for 4 seconds. When the control is powered up, the green *Power* light remains on continuously. For the first fifteen minutes after power up, the *Test* light flashes and the control responds immediately to changes of settings. This allows the installer to test the operation of the system. After 15 minutes the control enters its normal operating mode in which reactions to setting changes are significantly slower. A slower reaction time to setting changes allows the control to provide a stable room temperature.



Only in the first 15 minutes after power up, does the control respond immediatley to settings adjustments.

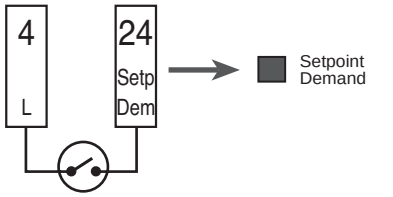
WARM WEATHER SHUT DOWN (WWSD)

When the outdoor temperature rises above the highest Room Temperature Unit (RTU) dial setting and all heating zones are satisfied, the *WWSD* light is turned on and zone relays are turned off. When an external Zone Control input is used, the *WWSD* light is only turned on when all the zones connected to the 371 and all the zones connected to the Zone Control are satisfied.



SETPOINT OPERATION

The 371 can be used to supply a fixed water temperature whenever a setpoint demand is provided. If 120 V (ac) is applied to terminal *Setp Dem* (24), the control registers a setpoint demand and turns on the *Setpoint Demand* light. The setpoint load can be connected to either the boiler (hot water) loop or mixing (warm water) loop.



BOILER OPERATION

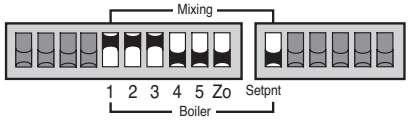
The 371 operates the boiler whenever there is a call for heat from boiler zones, mixing zones, DHW, or a setpoint load. The boiler supply water temperature is controlled by turning the boiler on and off. The 371 ensures sufficient heat is supplied to satisfy the demand for the hottest water temperature. In order to prevent boiler short cycling, the *Boiler* relay has a minimum off time of 20 seconds, and the boiler differential is automatically calculated.

Boiler Zones (hot water)

A boiler zone is selected by setting the zone DIP switch to *Boiler*. Once heat is required, the 371 uses an outdoor reset strategy with indoor temperature feedback from each of the boiler zones.

Mixing Zones (warm water)

A mixing zone is selected by setting the zone DIP switch to *Mixing*. When a mixing zone requires heat, the speed of the variable speed injection pump increases or the mixing valve opens. The 371 may also raise the boiler water temperature to satisfy the mixing heating load.

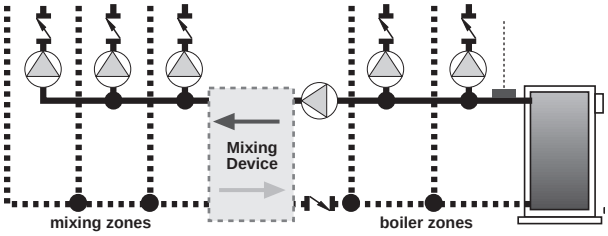


Setpoint Boiler Supply

If the *Setpnt* DIP switch is set to *Boiler* and setpoint operation is required, the 371 targets a boiler temperature of at least 180°F (82°C).

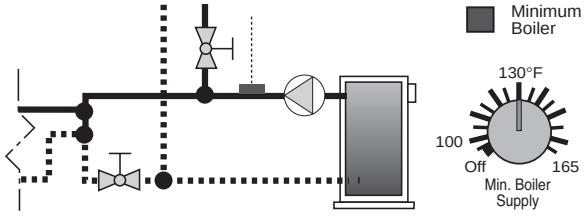
Boiler Maximum Supply

At no time does the 371 allow the target boiler supply water temperature to exceed 212°F (100°C).



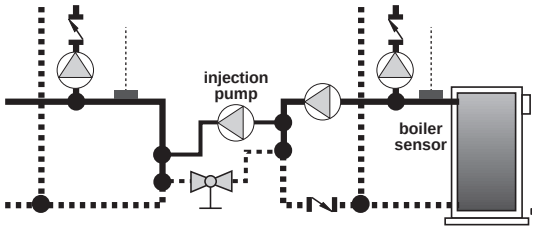
Boiler Minimum Supply

The 371 has a *Min. Boiler Supply* dial which sets a minimum target boiler supply temperature. This dial has an *Off* position for condensing and electric boilers. If the boiler is fired and the boiler supply temperature is near or below the *Min. Boiler Supply* dial setting, the 371 turns on the *Minimum Boiler* light and reduces the heating load on the boiler. During this warm up period, some of the zones may be prevented from operating until the boiler supply water is at the required minimum temperature.



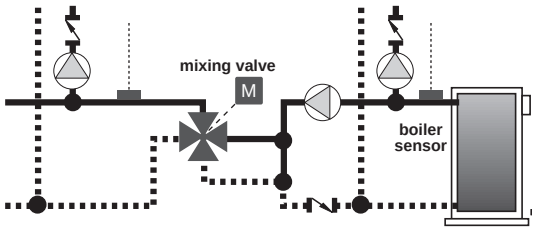
MIXING OPERATION

The 371 can supply a lower water temperature to part of the heating system by varying the speed of an injection pump or modulating a mixing valve. See Essay E 021 for more information. An outdoor reset strategy is used with indoor temperature feedback from each of the mixing zones.



Boiler Protection

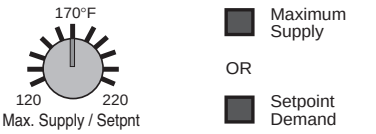
When the boiler is fired and the boiler supply temperature is below the *Min. Boiler Supply* dial setting, the 371 turns on the *Minimum Boiler* light and reduces the heating load on the boiler. During this warm up period, the mixing device is operated at low outputs and some of the zones may be prevented from operating.



System Maximum Supply / Setpoint Supply

The 371 has a *Max. Supply* dial that can be used to set an upper limit to the mixed supply water temperature. If this supply water temperature approaches the *Max. Supply* dial setting, the 371 turns on the *Maximum Supply* light and reduces the speed of the injection pump or closes the mixing valve.

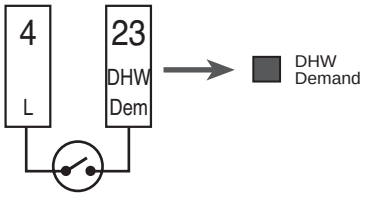
If the *Setpnt* DIP switch is set to *Mixing* and setpoint operation is required, the 371 controls the variable speed injection pump or the mixing valve in order to increase the mixed supply water temperature to the *Setpnt* dial setting.



DOMESTIC HOT WATER (DHW)

The DHW tank requests heat from the 371 through a DHW Demand. Whenever 120 V (ac) is applied to the *DHW Dem* (23) terminal on the 371, the control registers a DHW Demand and turns on the *DHW Demand* light. An aquastat, setpoint control or other switching device can be used to generate a DHW Demand by wiring the line voltage signal through the switching device and into the *DHW Dem* terminal.

The 371 does not turn on the boiler system pump (P1) when DHW is required, therefore piping a DHW tank to operate through a zone valve will increase wiring complexity.



DHW Supply Temperature

During DHW operation, the 371 targets a boiler water temperature of at least 180°F (82°C).

DHW Priority

The 371 is designed to provide DHW priority at all times. When a DHW demand is present, the control closes the contacts between *Power L — DHW Pmp* (4 and 22) and turns on the DHW pump. The boiler system pump (P1) and the boiler zone relays are turned off until the boiler water temperature is greater than 170°F (77°C).

DHW Post Purge

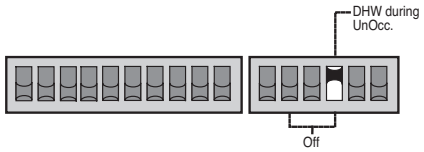
When the DHW Demand is removed and none of the zones require heat, the 371 turns off the boiler but continues to run the DHW pump. This purges some residual heat from the boiler. The 371 allows a maximum Post Purge time of 4 minutes. If the boiler supply temperature drops below 150°F (66°C) or below the *Min. Boiler Supply* dial setting, the 371 stops the DHW Post Purge.

DHW Mixing Purge

If some of the zones require heat, the 371 performs a DHW Mixing Purge. During the Mixing Purge period, the 371 simultaneously operates the DHW and heating systems. The 371 allows a maximum Mixing Purge period of 2 minutes for fast acting zone valves and pumps and a longer purge period for thermal motor zone valves. The actual length of the purge period is dependent on the boiler supply water temperature. At the end of the Mixing Purge period, the *DHW Pmp* relay is turned off but the system pumps (P1 and P2) and zone relays continue to operate.

DHW Setback

The *DHW during UnOcc.* DIP switch selects whether DHW setback is desired while the 371 is in UnOccupied mode. If the *DHW during UnOcc.* DIP switch is set to *Off*, the DHW Demand is ignored during the UnOccupied period. However, if *Optimum Start* is selected, the 371 will respond to the DHW Demand in the last hour of the UnOccupied mode. This will generally ensure that the DHW storage tank is up to temperature by the time the Occupied period begins. If the DIP switch is set to *DHW during UnOcc.*, the 371 responds to the DHW Demand at all times.



ZONING OPERATION

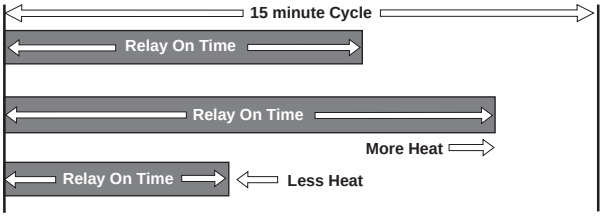
The 371 can directly control the temperature of up to 5 heating zones. In order to measure the indoor temperature, each zone requires either an Indoor Sensor or a Room Temperature Unit (RTU). With an RTU the desired zone temperature is set using the RTU dial, but with an Indoor Sensor the desired zone temperature is fixed at 72°F (22°C).


RTU


Indoor Sensor

PID Zone Temperature Control

The 371 operation is based on a 15 minute cycle. During every cycle the control turns on each zone relay for a specific on time. The required on time is calculated based on the PID response of the zone during the previous cycles. If the zone needs more heat, the on time is increased, and if the zone needs less heat, the on time is reduced. In order to prevent short cycling, the 371 ensures that the zone relays remain on or off for at least 3 minutes.

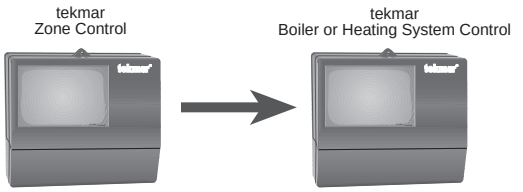


Zone Load Coordination

The 371 staggers the operation of the zones in order to achieve a steady load on the boiler while minimizing boiler running time and preventing boiler short cycling.

External Zone Control Input

Control of additional zones can be provided by connecting a tekmar Zone Control to the 371. The zone control can be added to control either boiler (hot water) or mixing (warm water) zones. If the *Zo* DIP switch is set to *Boiler*, the 371 assumes the additional zones are on the boiler (hot water) loop, and if the *Zo* DIP switch is set to *Mixing*, the 371 assumes the additional zones are on the mixing (warm water) side of the system.



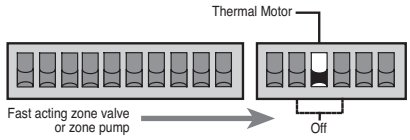
The Zone Control signals to the 371 whenever one of its zones requires heat. Upon receiving a Zone Control heat demand, the 371 shifts the Heating Curve to satisfy the heating requirements of both its own zones and the zones connected to the Zone Control.

Zone Control Load Synchronization

The 371 monitors the heat demand signals from the Zone Control and synchronizes the start times of its own zones with those of the Zone Control. More information on using a Zone Control with the 371 is provided in Application Brochures A 371.

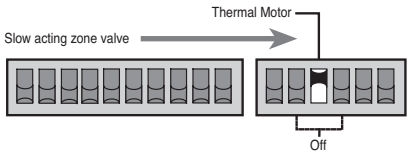
Fast Acting Zone Valves or Zone Pumps

If the *Thermal Motor* DIP switch is set to *Off*, the 371 assumes that fast acting electric motor zone valves or zone pumps are connected to all zone relays. The mixing system pump (P2) and / or boiler system pump (P1) is therefore turned on as soon as the first zone relay is operated. One minute before the last zone relay is turned off, the 371 purges the boiler.



Slow Acting Zone Valves with Thermal Motors

When the DIP switch is set to *Thermal Motor*, the 371 assumes that slow acting zone valves with thermal actuating motors are connected to all zone relays. With slow acting zone valves, the 371 allows a 3 minute period for the first zone valve to open before the mixing system pump (P2) and / or boiler system pump (P1) is turned on. The total operating time for the zone relays is also increased by an extra 2 minutes. This helps compensate for the longer opening versus closing time of the slow acting zone valves. For one minute after the last zone relay is turned off, the 371 purges the boiler.

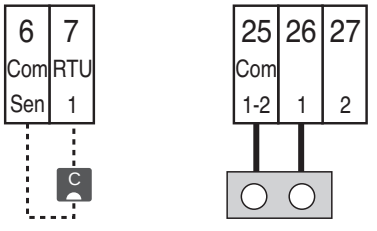


COOLING OPERATION

When the DIP switch on the 371 is set to *Zone 1 Cool*, zone relay *1* can either be used to enable an auxiliary cooling control system or to directly operate a central cooling unit.

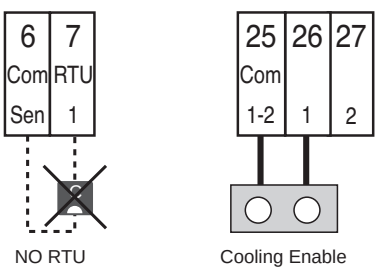
Cooling Control (RTU is present)

If *Zone 1 Cool* is selected and an RTU or Indoor Sensor is connected to terminals *Com Sen — RTU 1* (6 & 7), the 371 can directly control a central cooling system using zone relay *1*. If an RTU is used, the desired indoor temperature is set using the RTU dial down to 73°F (23°C), but if an Indoor Sensor is used, the desired indoor temperature is fixed at 77°F (25°C). Zone relay *1* is allowed to turn on once the heating zones in the 371 have been satisfied for at least 45 minutes, and is turned off whenever any zone requires heat. The 371 varies the on time of zone relay *1* over a 30 minute cycle. As the cooling load increases, the on time of the zone relay increases. In order to prevent short cycling, the 371 ensures that zone relay *1* remains on or off for at least 3 minutes.



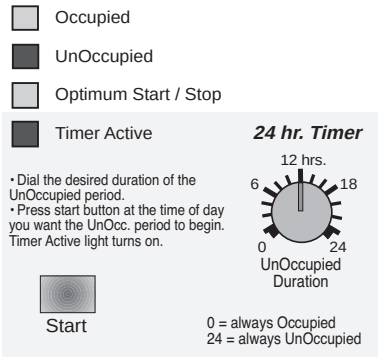
Cooling Enable (no RTU)

If *Zone 1 Cool* is selected and there is no RTU or Indoor Sensor connected to terminals *Com Sen — RTU 1* (6 & 7), the 371 can enable an auxiliary cooling control through zone relay *1*. Zone relay *1* is turned on once the heating zones in the 371 have been satisfied for at least 45 minutes, and is turned off whenever any zone requires heat.



UNOCCUPIED (NIGHT SETBACK)

The 371 can be switched into UnOccupied mode through the built-in 24 hr. Timer or by closing an external switch or timer relay wired between the terminals *Com Sen — UnO Sw* (13 & 14) on the control.



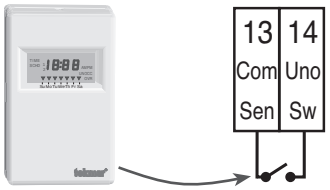
Timer, 24 hr.

The 371 has a built-in 24 hr. Timer which can be used to set a single UnOccupied event during a 24 hour period. The 24 hr. Timer is activated by pushing the *Start* button at the desired starting time for the UnOccupied period. The duration of the UnOccupied period is set using the *UnOccupied Duration* dial. Once the *Start* button is pushed, the *Timer Active* light is turned on and the 371 enters the UnOccupied mode each day at the same starting time. The 24 hr. Timer can be deactivated by pressing the *Start* button again. A new UnOccupied period starting time can then be selected by repeating the above procedure.

Note: If an external switch is closed between the terminals *Com Sen — UnO Sw* (13 and 14), the 24 hr. Timer is disabled. An external UnOccupied switch and the 24 hr. Timer should not be used at the same time.

UnOccupied Switch Input

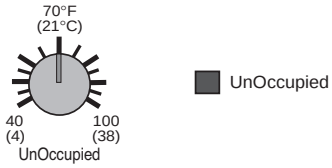
A switch or external timer with a dry relay contact output can be wired between the terminals *Com Sen — UnO Sw* (13 and 14) on the 371. When the switch or relay contact is closed, the 371 registers an UnOccupied signal. A tekmar Timer 031 is available which can be programmed to provide UnOccupied schedules for each day of the week with up to two separate UnOccupied events per day. For more information on the Timer 031, see the Data Brochure D 031.



UnOccupied Temperature

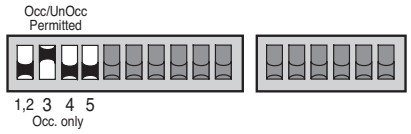
When the 371 is in UnOccupied mode, the *UnOccupied* light is turned on and the *UnOccupied* dial is used to set the desired temperature within the UnOccupied zones.

Note: If the RTU dial for an UnOccupied zone is set below the *UnOccupied* dial, the 371 continues to use the RTU dial as the desired temperature within that zone.



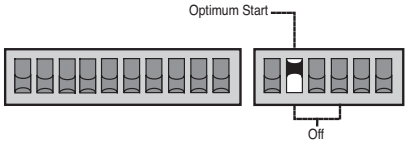
Individual Zone Selection

The DIP switches on the 371 are used to select which zones are switched into UnOccupied mode. If the DIP switch for a specific zone is set to *Occ / UnOcc*, that zone is switched into UnOccupied mode whenever the 371 receives an UnOccupied signal. If the DIP switch for a specific zone is set to *Occ. only*, that zone remains in the Occupied mode at all times.



Optimum Start / Stop

The Optimum Start / Stop feature is enabled when the DIP switch is set to *Optimum Start.* The 371 turns on the *Optimum Start / Stop* light each time the first zone enters its delay or recovery period. Either the tekmar Timer 031 or the built-in 24 hr. Timer on the 371 can be used with the Optimum Start / Stop feature. The tekmar Timer 031 has a DIP switch which must be set to *Optimum Start / Stop* in order to synchronize the timer with the 371 Optimum Start / Stop function.



SYSTEM PUMP OPERATION

The 371 has two system pump terminals, one for the boiler (hot water) loop, *Sys P1* (1), and one for the mixing (warm water) loop, *Sys P2* (2). The *System Pump 1* light is turned on every time the relay contact between terminals *Sys P1 — Power L* (2 & 4) is closed, and the *System Pump 2* light is turned on every time the relay contact between terminals *Sys P2 — Power L* (1 & 4) is closed.

The boiler system pump (P1) operates whenever any zone requires heat. The mixing system pump (P2) operates whenever any of the mixing zones require heat. ***This includes any zones in connected tekmar Zone Control.*** If thermal motor zone valves are used, the mixing and boiler system pumps (P1 and P2) are held off for the first three minutes of the zone cycle in order to give the zone valve sufficient time to open. With thermal zone valves the system pumps may also operate for an additional purge period once the zone relays are turned off.

During DHW operation, the 371 turns the boiler system pump (P1) off. For other details of the operation of the system pumps during DHW operation, see the DHW section on page 7.

If a *S*etpoint Demand is provided and the DIP switch is set to *Boiler*, the 371 does not turn the boiler system pump (P1) or the mixing system pump (P2) on. If the DIP switch is set to *Mixing*, the 371 turns the boiler system pump on, but does not turn the mixing system pump on.

Integrated Exercising

The zone valves, zone pumps, system pumps, and the mixing device are exercised to help prevent corrosion from building up and subsequently jamming the equipment. Every three days the 371 runs through an exercising procedure.

Exercising Procedure

The 371 first exercises the zone valves or pumps. If a zone valve or zone pump has not been operated in the past 3 days, the 371 turns on the zone relay for 10 seconds.

Note The zone relay exercising time is increased to 3 minutes if the DIP switch is set to *Thermal Motor*.

After the zone valves or pumps have been exercised, the 371 exercises the mixing system pump (P2) and the boiler system pump (P1). If the system pumps have not operated in the past 3 days, the 371 turns on the *Sys P1* and the *Sys P2* relays for 10 seconds.

After the system pumps have been exercised, then, if any of the DIP switches are set to *Mixing* and a variable speed injection pump is used, the 371 turns on the variable speed injection pump every 3 days at full speed for 10 seconds. If a mixing valve is used, the control fully opens and closes the valve.

Once the exercising procedure is complete, the 371 returns to its normal operating sequence.

Installation

Caution

Improper installation and operation of this control could result in damage to the equipment and possibly even personal injury. It is your responsibility to ensure that this control is safely installed according to all applicable codes and standards. This electronic control is not intended for use as a primary limit control. Other controls that are intended and certified as safety limits must be placed into the control circuit.

STEP ONE — GETTING READY

Check the contents of this package. If any of the contents listed are missing or damaged, please contact your wholesaler or tekmar sales representative for assistance.

Type 371 includes:
- One House Control 371
- One Outdoor Sensor 070
- Two Universal Sensors 071
- Data Brochures D 371, D 070, D 001
- Application Brochures A 371
- Essay E 021

Other information available:
- A 000, I 030, D 054, D 074

Note *Carefully read the details of the Sequence of Operation sections in all applicable brochures to ensure that you have chosen the proper control for your application.*

STEP TWO — MOUNTING THE BASE

Remove the control from its base by pressing down on the release clip in the wiring chamber and sliding the control upwards. The base is then mounted in accordance with the instructions in the Data Brochure D 001.

STEP THREE — ROUGH-IN WIRING

All electrical wiring terminates in the control base wiring chamber. The base has standard 7/8" (22 mm) knockouts which accept common wiring hardware and conduit fittings. Before removing the knockouts, check the wiring diagram and plan the routing of wires. The control base can be installed on a 4-3/4” x 4-3/4” electrical box to simplify line voltage wiring.

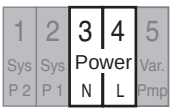
Power must not be applied to any of the wires during the rough-in wiring stage.

- Install the Outdoor Sensor 070, Boiler Sensor 071, and the Supply Sensor 071 according to the instructions in the Data Brochure D 070 and run the wiring back to the control.
- If a 10K Indoor Sensor is used, install the Indoor Sensor(s) according to the installation instructions in the Data Brochure D 074 and run the wiring back to the control.
- If a 10K RTU is used, install the RTU(s) according to the installation instructions provided in the Data Brochure D 054 and run the wiring back to the control.
- If a Zone Control is used, run the wires from the Zone Control to the 371. Refer to the instructions supplied with the Zone Control.
- Run wiring from the other system components (pumps, DHW demand, boiler, motorized zone valves, etc.) to the control. Multi-strand 16 AWG wire is recommended for all 120 V (ac) wiring due to its superior flexibility and ease of installation into the terminals.
- Run wires from the 120 V (ac) power to the control. *Use a clean power source to ensure proper operation.*

STEP FOUR — ELECTRICAL CONNECTIONS TO THE CONTROL

The installer should test to confirm that no voltage is present at any of the wires. Push the control into the base and slide it down until it snaps in firmly.

Powered Input Connections

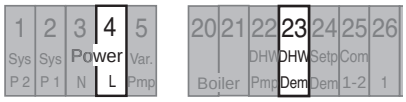


120 V (ac) Power

Connect the 120 V (ac) power supply to terminals *Power N — L* (3 and 4).

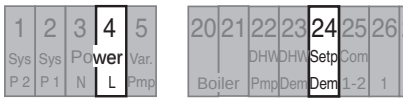
DHW Demand

If a DHW demand is used, connect the switched wire from the DHW demand circuit to terminal *DHW Dem* (23). When 120 V (ac) relative to *Neutral* (N) is applied to this terminal, the control recognizes a DHW demand.



Setpoint Demand

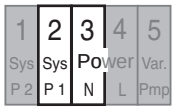
If a setpoint demand is used, connect the switched wire from the setpoint demand circuit to terminal *Setp Dem* (24). When 120 V (ac) relative to *Neutral* (N) is applied to this terminal, the control recognizes a setpoint demand.



Output Connections

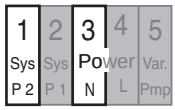
Boiler System Pump (P1)

Connect one wire from the boiler system pump to the *Sys P1* (2) terminal on the control. The other wire on the boiler system pump must be connected to the *Neutral (N)* side of the 120 V (ac) power supply. The control closes a dry relay contact between *Sys P1 — Power L* (2 and 4) when operation of the boiler system pump is required.



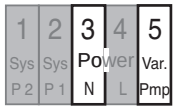
Mixing System Pump (P2)

Connect one wire from the mixing system pump to the *Sys P2* (1) terminal on the control. The other wire on the mixing system pump must be connected to the *Neutral (N)* side of the 120 V (ac) power supply. The control closes a dry relay contact between *Sys P2 — Power L* (1 and 4) when operation of the mixing system pump is required.



Variable Speed Injection Pump

The 371 can vary the speed of a permanent capacitor, impedance protected or equivalent pump motor that has a locked rotor current of less than 2.4 A. Most small wet rotor circulators are suitable as described in Essay E 021. *The variable speed output must not be used on pumps which have a centrifugal switch.* The 371 has an internal overload protection fuse which is rated at 2.5 A 250 V (ac). This fuse is not field replaceable. Contact your tekmar sales representative for details on the return and repair procedures if this fuse is blown.



Connect one wire from the variable speed injection pump to the *Var. Pmp* (5) terminal on the control. The other wire on the variable speed injection pump must be connected to the *Neutral (N)* side of the 120 V (ac) power supply, or to L2 for a 240 V (ac) power supply. The control varies the power to the pump in order to change its speed.

Mixing Valve Actuator

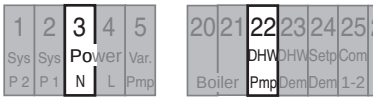
Connect one side of the 24 V (ac) circuit to terminal *Com 3-5* (28). The output relay *Opn 4* (30) is then connected to the open terminal of the actuating motor and the output relay *Cls 5* (31) is connected to the close terminal of the actuating motor.

Boiler

Connect the 120 V (ac) or 24 V (ac) Boiler circuit to terminals *Boiler — Boiler* (20 and 21). The 371 closes a dry relay contact between these terminals when boiler operation is required.

DHW Pump

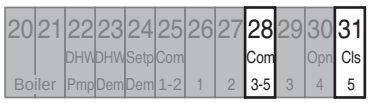
Connect one wire from the DHW pump to the *DHW Pmp* (22) on the control. The other wire on the DHW pump must be connected to the *Neutral* (N) side of the 120 V (ac) power supply. The control closes a dry relay contact between the *Power L — DHW Pmp* (4 and 23) terminals when DHW heating is required.



Zone Pumps and Zone Valves

It is best to start the heating zones at output relay *5* and work towards the output relay *1*.

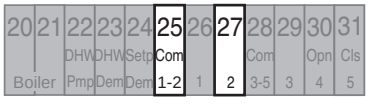
- If Zone 5 is used for heating, connect the Zone 5 Pump or Valve circuit to the *Com 3-5 — 5* (28 and 31) terminals on the control.



- If Zone 4 is used for heating, connect the Zone 4 Pump or Valve circuit to the *Com 3-5 — 4* (28 and 30) terminals on the control.

- If Zone 3 is used, connect the Zone 3 Pump or Valve circuit to the *Com 3-5 — 3* (28 and 29) terminals on the control.

- If Zone 2 is used, connect the Zone 2 Pump or Valve circuit to the *Com 1-2 — 2* (25 and 27) terminals on the control.

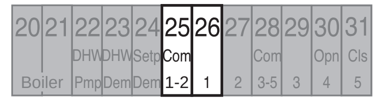


- If Zone 1 is used for heating (DIP switch set to *Zone 1 Heat*), connect the wire from the Zone 1 Pump or Valve to the *Com 1-2 — 1* (25 and 26) terminals on the control.

Note Do not connect a zone pump (120 V (ac)) and zone valve (24 V(ac)) circuit to the same *Com* terminal. The 371 closes a dry relay contact between the *Com* and output terminals when a zone requires heat.

Cooling System

If a cooling system is used and the DIP switch is set to *Zone 1 Cool*, connect the wires from the cooling unit isolation relay to terminals *Com 1-2 — 1* (25 and 26) on the control. The 371 closes a dry relay contact between these terminals when cooling is required.

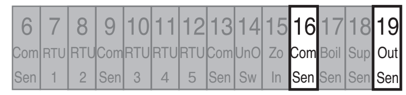


Sensor and Unpowered Input Connections

Do not apply power to these terminals as this will damage the control.

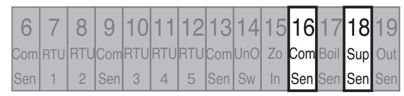
Outdoor Sensor

Connect the two wires from the Outdoor Sensor 070 to the terminals *Com Sen — Out Sen* (16 and 19). The Outdoor Sensor measures the outdoor air temperature.



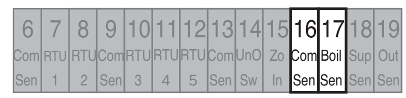
Supply Sensor

Connect the two wires from the Supply Sensor 071 to terminals *Com Sen — Sup Sen* (16 and 18). The Supply Sensor measures the supply water temperature after mixing has occurred.



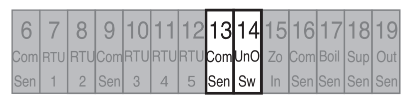
Boiler Sensor

Connect the two wires from the Boiler Sensor 071 to terminals *Com Sen — Boil Sen* (16 and 17). The Boiler Sensor measures the supply water temperature from the boiler.



UnOccupied Switch

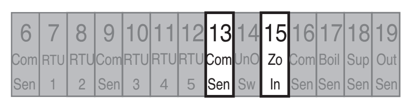
If an external timer or switch is used, connect the two wires from the external dry contact switch to the *Com Sen —UnO Sw* (13 and 14) terminals. When these terminals short together, the control registers an UnOccupied signal.



Note If an external switch is closed between the terminals *Com Sen — UnO Sw* (13 and 14), the 24 hr. Timer is disabled. Either the 24 hr. Timer or an external timer/ switch can be used, not both at the same time.

Zone Control Input

If an external Zone Control is used, connect the wire from the *Com Sen* terminal on the Zone Control to terminal *Com Sen* (13) on the 371. Connect the wire from the *Zo Out* terminal on the Zone Control to terminal *Zo In* (15) on the 371.



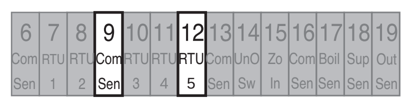
Note The wires from the Zone Control are polarity sensitive. The system will not operate if the wires are reversed.

Room Temperature Units (RTU) and Indoor Sensors

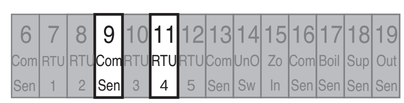
RTUs and / or Indoor Sensors provide indoor temperature feedback to the control.

DIP Switch set to *Zone 1 Heat* and *Var. Speed*

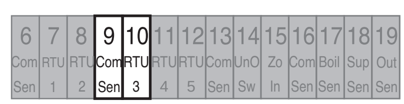
- If zone 5 is used, connect an RTU or Indoor Sensor to the *Com Sen — RTU 5* (9 and 12) terminals on the control.



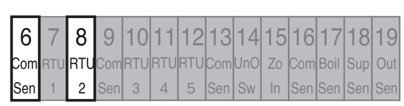
- If zone 4 is used, connect an RTU or Indoor Sensor to the *Com Sen — RTU 4* (9 and 11) terminals on the control.



- If zone 3 is used, connect an RTU or Indoor Sensor to the *Com Sen — RTU 3* (9 and 10) terminals on the control.



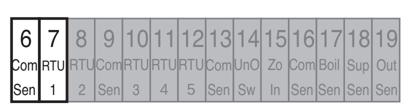
- If zone 2 is used, connect an RTU or Indoor Sensor to the *Com Sen — RTU 2* (6 and 8) terminals on the control.



- If zone 1 is used for heating, an RTU or Indoor Sensor must be connected to the *Com Sen — RTU 1* (6 and 7) terminals on the control.

DIP Switch set to *Zone 1 Cool*

- If the zone *1* relay is used to enable an external cooling control system, an RTU or Indoor Sensor is not required for this zone.
- If the zone *1* relay is used to control a cooling unit, an RTU or Indoor Sensor must be connected to the *Com Sen — RTU 1* (6 and 7) terminals on the control.

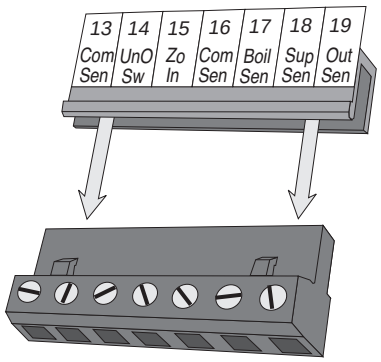


DIP switch set to *Floating*

- An RTU or Indoor Sensor connected to terminals *Com Sen — RTU 5* (9 and 12) or Com Sen — RTU 4 (9 and 11) does not operate a zone relay, but it will provide indoor temperature feedback to the mixed supply.
- Other zones can use an RTU or Indoor Sensor as described above.

STEP FIVE — TESTING THE WIRING

Each terminal block must be unplugged from its header on the control before power is applied for testing. Pull straight down to unplug the terminal block.

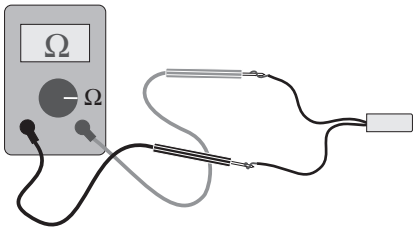


The following tests are to be performed using standard testing practices and procedures and should only be carried out by properly trained and experienced persons.

A good quality electrical test meter, capable of reading from at least 0 — 300 V (ac) and at least 0 — 2,000,000 Ohms, is essential to properly test the wiring and sensors.

Test the Sensors

In order to test the sensors and Room Temperature Units (RTUs), the actual temperature at each sensor and RTU location must be measured. A good quality digital thermometer with a surface temperature probe is recommended for ease of use and accuracy of testing. Where a digital thermometer is not available, a spare sensor can be strapped alongside the one to be tested and the readings compared. Test the sensors and RTU(s) according to the instructions in the Data Brochures D 074 and D 054.



Test the Power Supply

Make sure exposed wires or bare terminals are not in contact with other wires or grounded surfaces. Turn on the power and measure the voltage between the *Power N — L* (3 and 4) terminals using an AC voltmeter, the reading should be between 110 and 130 V (ac).

Test the Powered Inputs

DHW Demand

If a DHW Demand is used, measure the voltage between the *Power N* (3) and *DHW Dem* (23) terminals. When the DHW Demand device (aquastat etc.) calls for heat, you should measure between 110 and 130 V (ac) at the terminals. When the DHW Demand device is off, you should measure less than 5 V (ac).

Setpoint Demand

If a Setpoint demand is used, measure the voltage between the *Power N* (3) and *Setp Dem* (24) terminals. When the Setpoint Demand device (aquastat, etc.) calls for heat, you should measure between 110 and 130 V (ac) at the terminals. When the Setpoint Demand device is off, you should measure less than 5 V (ac).

Test the Outputs

Boiler System Pump (P1)

If a boiler system pump is connected to the *Sys P1* (2) terminal, make sure power to the terminal block is off and install a jumper between the terminals *Sys P1 — Power L* (2 and 4). When power is applied to the terminals *Power N — L* (3 and 4), the boiler system pump should start. If the pump does not turn on, check the wiring between the terminal block and the pump and refer to any installation or troubleshooting information supplied with the pump. If the pump operates properly, disconnect the power and remove the jumper.

Mixing System Pump (P2)

If a mixing system pump is connected to the *Sys P2* (1) terminal, make sure power to the terminal block is off and install a jumper between the terminals *Sys P2 — Power L* (1 and 4). When power is applied to the terminals *Power N — L* (3 and 4), the mixing system pump (P2) should start. If the pump does not turn on, check the wiring between the terminal block and the pump and refer to any installation or troubleshooting information supplied with the pump. If the pump operates properly, disconnect the power and remove the jumper.

Variable Speed Injection Pump

If a variable speed injection pump is connected to the terminal *Var. Pmp* (5), make sure power to the terminal block is off and install a jumper between the terminals *Power L — Var . Pmp* (4 and 5). When power is applied to terminals *Power N — L* (3 and 4), the variable speed injection pump should operate at full speed. If the pump does not operate, check the wiring between the terminal block and the pump and refer to any installation or troubleshooting information supplied with the pump. If the pump operates properly, disconnect the power and remove the jumper.

Mixing Valve Actuator

If a floating action actuating motor is connected to terminals *Com 3-5 — Opn 4 — Cls 5* (28, 30 and 31), make sure power to the motor circuit is off and install a jumper between terminals Com 3-5 — *Opn 4* (28 and 30). When the circuit is powered up, the valve should start to open. If it does not, check the wiring between the terminal and the actuating motor and refer to any installation or troubleshooting information supplied with the motor. If the valve closes instead of opening, the wiring to the actuating motor must be reversed. If the valve opens correctly, turn off the power to the circuit and remove the jumper. Install a jumper between the terminals *Com 3-5 — Cls 5* (28 and 31). When the circuit is powered up, the valve should start to close. If it does not, check the wiring between the terminal and the actuating motor and refer to any installation or troubleshooting information supplied with the motor. If the valve closes correctly, turn off the power to the circuit and remove the jumper.

Boiler

If a boiler is connected to the terminals *Boiler — Boiler* (20 and 21), make sure power to the boiler circuit is off and install a jumper between the terminals. When the boiler circuit is powered up, the boiler should fire. If the boiler does not turn on, refer to any installation or troubleshooting information supplied with the boiler and/or Boiler Control. If the boiler operates properly, disconnect the power and remove the jumper.

DHW Pump

If a DHW pump is connected to the *DHW Pmp* (22), make sure the power to the pump circuit is off and install a jumper between the *Power L — DHW Pmp* (4 and 22) terminals. When the DHW circuit is powered up, the DHW pump should turn on. If the DHW pump does not operate, check the wiring between the terminals and the pump and refer to any installation or troubleshooting information supplied with the pump.

Zone Pump or Valve

- If a zone pump or zone valve is connected to the terminals *Com 3-5 —5* (28 and 31), make sure power to the pump or valve circuit is off and install a jumper between the terminals *Com 3-5— 5* (28 and 31). When the zone circuit is powered up, the zone pump should turn on or the zone valve should open completely. If no response occurs, check the wiring between the terminal and the pump or valve and refer to any installation or troubleshooting information supplied with these devices.
- If a zone pump or valve is connected to the terminals *Com 3-5 — 4* (28 and 30), follow a similar procedure as described above for the zone *5* relay.
- If a zone pump or valve is connected to the terminals *Com 3-5 — 3* (28 and 29), follow a similar procedure as described above for the zone *5* relay.
- If a zone pump or valve is connected to the terminals *Com 1-2 — 2* (25 and 27), follow a similar procedure as described above for the zone *5* relay.
- If a zone pump, valve or cooling circuit is connected to the terminals *Com 1-2— 1* (25 and 26), follow a similar procedure as described above for the zone *5* relay.

Connect the Control

- Make sure all power to the devices and terminal blocks is off and remove any remaining jumpers from the terminals.
- Reconnect the terminal blocks to the control by carefully aligning them with their respective headers on the control and then pushing the terminal blocks into the headers. The terminal blocks should snap firmly into place.
- If required, install the supplied safety dividers between the unpowered sensor inputs and the powered 120 V (ac) or 24 V (ac) wiring chambers.
- Do not apply power to the control until the adjustment dials and DIP switches are properly set for your application. See the Settings section of this brochure for details on how to set the dials and DIP switches.
- Once the settings are complete, apply power to the control. The operation of the control on power up is described in the Sequence of Operation section of this brochure.

Settings

Before adjusting the dial settings, read through the Sequence of Operation section of this brochure to ensure that you understand how the control operates.

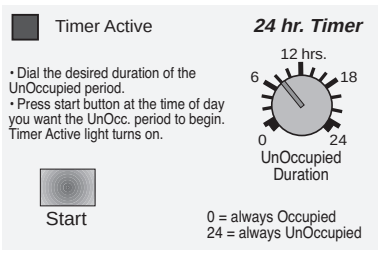
STEP SIX — ESSENTIAL CONTROL SETTINGS

Using the Internal Timer, 24 hr.

First determine the length of time required for the UnOccupied period and turn the *UnOccupied Duration* dial to the desired duration length. If the dial is set to 24 hours, the 371 remains in UnOccupied mode continuously. If the dial is set to 0 hours, the 371 remains in Occupied mode continuously.

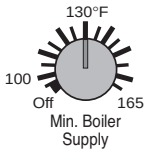
Press the *Start* button at the desired starting time for the UnOccupied period. Once the *Start* button is pressed, the 371 enters the UnOccupied period at the same starting time each day.

Example: The user wants an UnOccupied period starting at 10 pm and ending at 6 am. The *Unoccupied Duration* dial is set to 8 hours and the *Start* button is pressed at 10 pm. Once the *Start* button is pressed, the control goes into UnOccupied mode from 10 pm until 6 am the next morning. This cycle will be repeated every day of the week.



Boiler Minimum Supply

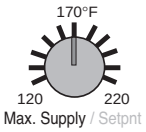
Most boilers require a minimum operating temperature to prevent corrosion from flue gas condensation. The *Min. Boiler Supply* dial should be set to the lowest supply water temperature at which the boiler can operate without causing the boiler flue gases to condense. Consult the boiler manufacturer for recommended boiler minimum supply temperatures. Some typical settings are given below. If a condensing or electric boiler is used, the *Min. Boiler Supply* dial is normally set to *Off*.



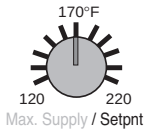
Typical settings:
- Steel fire tube boilers . . . . . 140 to 160°F (60 to 71°C)
- Cast iron boilers . . . . . 135 to 160°F (57 to 71°C)
- Copper tube boilers . . . . . 135 to 150°F (57 to 66°C)

System Maximum Supply

The 371 seeks to prevent the mixed supply water temperature from rising above the *Max. Supply* dial setting. The *Max. Supply* dial should be set to the maximum temperature allowed in the mixing loop. There are many factors which may limit the allowable supply temperature in a radiant floor heating slab. A few of these are provided below.



- Some tubing manufacturers recommend that their products not be maintained at temperatures exceeding 140°F (60°C). Consult the tubing manufacturer for specific details.
- Nowhere in the concrete should the temperature be maintained above 170°F (77°C).
- The surface temperature of a radiant floor heating slab should normally not exceed 85°F (29°C). The slab surface temperature is affected by the supply water temperature to the slab as well as the slab thermal resistance and heating load.

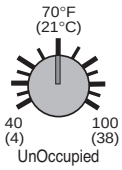


Setpoint Temperature

If the *Setpnt* DIP switch is set to *Mixing* and a Setpoint Demand is provided, the 371 increases the mixed supply water temperature to the *Setpnt* dial setting. The *Setpnt* dial should be set to the required setpoint temperature or to the maximum supply temperature allowed by the system.

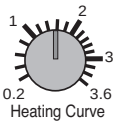
Unoccupied Temperature

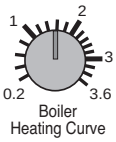
The *UnOccupied* dial sets the desired indoor temperature during UnOccupied (Night Setback) mode. When a Zone Control is used, the zones connected to the Zone Control are not affected by the *UnOccupied* dial on the 371. The Zone Control has its own UnOccupied mode which is explained in more detail in the Data Brochure supplied with the Zone Control.



Heating Curves

The 371 House Control has two independent Heating Curve dials; one for the boiler loop (*Boiler Heating Curve*) and one for the mixing loop (*Heating Curve*). The *Heating Curve* dial settings determine the number of degrees the supply water temperature is raised for every one degree drop in outdoor temperature. The *Heating Curve* dial positions can be calculated from the following formula. Normally the two Heating Curves are different values.



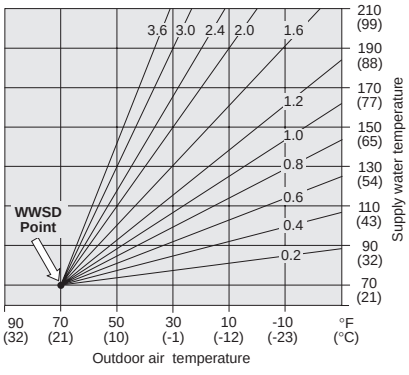


$$\text{Heating Curve} = \frac{\text{design supply temperature} - \text{design room temperature}}{\text{design room temperature} - \text{design outdoor temperature}}$$

Example: A system is designed to supply 120°F (49°C) mixed water and 180°F (82°C) boiler water when the outdoor temperature is 10°F (-12°C) and the room temperature is 70°F (21°C).

$$\text{Heating Curve} = \frac{120 - 70°F\ (49 - 21°C)}{70 - 10°F\ (21 - (-12)°C)} = \frac{50°F\ (28°C)}{60°F\ (16°C)} = 0.8$$

$$\text{Boiler Heating Curve} = \frac{180 - 70°F\ (82 - 21°C)}{70 - 10°F\ (21 - (-12)°C)} = \frac{110°F\ (43°C)}{60°F\ (16°C)} = 1.8$$



If the design supply water temperature is unknown, the *Heating Curve* dial can be set to a trial value calculated from the typical design supply water temperatures given below.

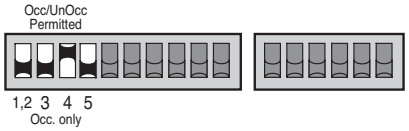
- Hydronic radiant floors .....100 to 130°F (38 to 54°C)
- Baseboard radiators .....160 to 190°F (71 to 88°C)
- Fan coils .....180 to 210°F (82 to 99°C)

DIP Switch Settings

Note Once the control is in operation, the control will not update any changes in the DIP switches until the next heating or cooling cycle.

Occ / UnOcc — Occ. Only

Each zone can be selected to operate in either Occupied only mode or in both Occupied and UnOccupied modes. If the DIP switch is set to *1,2 Occ. only*, the zones connected to relays *1* and *2* remain in the Occupied mode at all times. If the DIP switch is set to *1,2 Occ / UnOcc*, zones *1* and *2* are switched into UnOccupied mode each time the 371 receives an UnOccupied signal. Zones *3*, *4*, and 5 can be individually selected for Occupied only or both UnOccupied and Occupied mode operation.

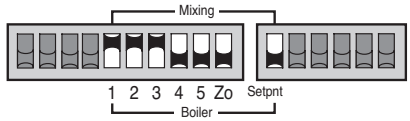


Mixing — Boiler

Each zone can be individually selected to operate either in the *Boiler* mode or *Mixing* Mode. If a zone's DIP switch is set to *Mixing*, the 371 assumes this zone is in the mixing (warm water) loop, and if the zone's DIP switch is set to *Boiler*, the 371 assumes the zone is in the boiler (hot water) loop.

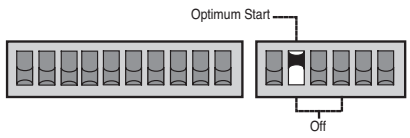
If a zone control is connected with the 371 and it is used to control boiler (hot water) zones the *Zo* DIP switch must be set to *Boiler*. If the zone control is operating mixing (warm water) zones, the *Zo* DIP switch must be set to *Mixing*.

If a setpoint demand is used to control a boiler (hot water) load, the *Setpnt* DIP switch must be set to *Boiler*. If the setpoint demand controls a mixing (warm water) load the *Setpnt* DIP switch must be set to *Mixing*.



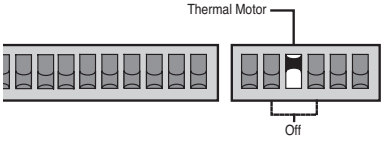
Optimum Start

The Optimum Start / Stop feature is used during transitions between the UnOccupied mode (Night Setbback) and the Occupied mode. When the DIP switch is set to *Optimum Start*, the 371 raises the building temperature during the final stages of the UnOccupied period. This helps ensure the building is at the Occupied temperature as soon as the Occupied period begins. If the Optimum Start DIP switch is set to *Off*, the 371 does not start raising the building temperature until the UnOccupied period ends. More information on the Optimum Start feature is provided on page 5 of this brochure.



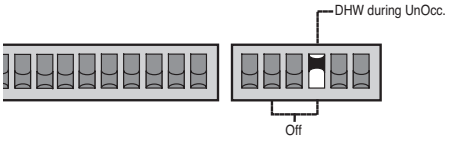
Thermal Motor

Zone valves with thermal actuating motors have long opening and closing times. In order for the 371 to compensate for these longer times, the DIP switch should be set to *Thermal Motor*. If fast acting electric motor zone valves or zone pumps are used, the DIP switch must be set to *Off*.



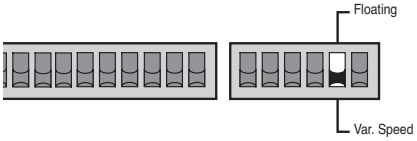
DHW during UnOcc.

If the DHW tank requires heating during the UnOccupied mode, the DIP switch should be set to *DHW during UnOcc.*. When this DIP switch is set to *Off*, the 371 ignores all DHW demands during the UnOccupied period.



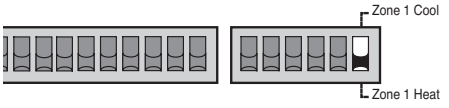
Floating / Var. Speed

The 371 can provide mixing reset by operating a variable speed injection pump or by modulating a mixing valve. If variable speed injection pumping is used , the DIP switch must be set to *Var. Speed*. If a mixing valve actuator is connected to terminals *Opn 4 — Cls 5* (30 and 31), the DIP switch must be set to *Floating*.



Zone 1 Cool / Zone 1 Heat

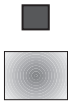
The zone *1* relay can be used to control a heating zone or to operate a cooling system. If zone *1* is to be used for a heating zone, the DIP switch must be set to *Zone 1 Heat*. If zone *1* is used for cooling, the DIP switch must be set to *Zone 1 Cool*.



Testing the Control

STEP SEVEN — OPERATIONAL TEST OF CONTROL FUNCTIONS

The House Control 371 has a test routine which is used to test the main control functions. The 371 continually checks the sensors and displays an error message whenever a fault is found. See page 19 for the list of error messages. When the *Test* button is pushed, the *Test* light is turned on. The *WWSD, Maximum Supply, Minimum Boiler and Optimum Start / Stop* lights are turned off and the individual outputs and relays are tested in the following test sequence.



Test Sequence

Each step in the test sequence lasts 10 seconds. At the end of each step, the device continues to operate until it is turned off in a later step.

During the test routine, the test sequence can be paused by pressing the *Test* button. The test sequence remains paused at that point for up to 5 minutes. If the *Test* button is not pressed again while the test sequence is paused, the control exits the entire test routine. Once the test sequence is paused, the *Test* button can be pressed again to skip to the next step. This can also be used to rapidly skip through the test sequence. To reach the desired step, repeatedly press and release the *Test* button until the appropriate device and indicator light turn on.

Step 1 - If the DIP switch is set to *Var. Speed* and there is at least one DIP switch set to *Mixing*, the variable speed injection pump is ramped up to 100% over 10 seconds. If the DIP switch is set to *Floating*, the open relay is turned on for 10 seconds. If you wish to run the mixing valve fully open, pause the test routine at this time.

Step 2 - The *DHW Pmp* relay is turned on.

Step 3 - The *Sys P2* relay is turned on.

Step 4 - The *Sys P1* relay is turned on.

Step 5 - The *Boiler* relay is turned on.

Step 6 - The *DHW Pmp*, *Sys P1, Sys P2, Boiler* and *Variable Speed Injection Pump* are turned off. If the DIP switch is set to *Floating,* the close relay is turned on.

Step 7 - If the DIP switch is set to *Var. Speed* and an RTU / Indoor Sensor is connected to terminals *Com Sen — RTU 5* (9 and 12), the control turns on the *zone 5* relay for 10 seconds.

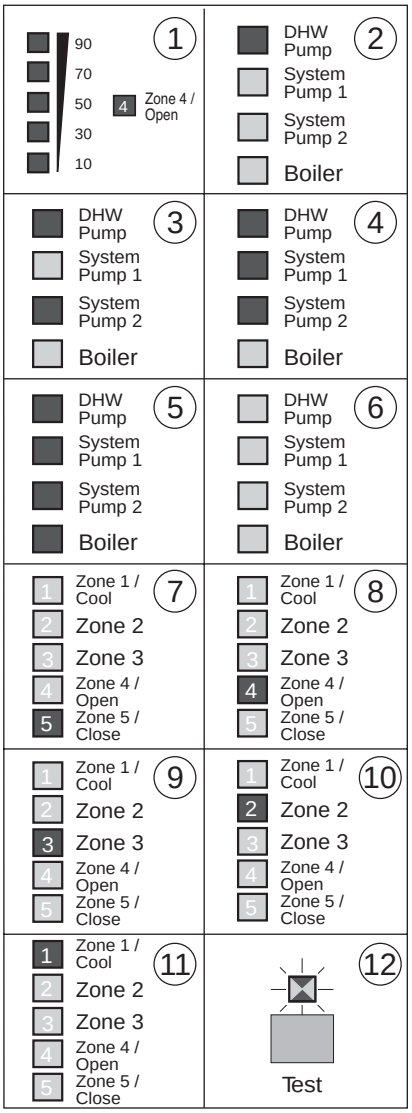
Step 8 - If the DIP switch is set to *Var. Speed* and an RTU or Indoor Sensor is connected to the terminals *Com Sen — RTU 4* (9 and 11), the control turns on the zone *4* relay for 10 seconds.

Step 9 - If an RTU or Indoor Sensor is connected to the terminals *Com Sen — RTU 3* (9 and 10), the control turns on the zone *3* relay for 10 seconds.

Step 10 - Once the zone *3* relay is turned off, the control follows a similar procedure to test the zone *2* relay. If an RTU or Indoor Sensor is not connected to the terminals *Com Sen — RTU 2* (6 and 8), the control skips this step.

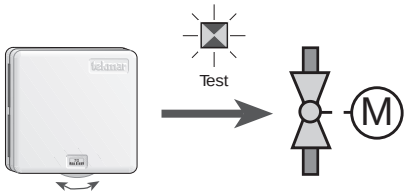
Step 11 - Once the zone *2* relay is turned off, the control tests the zone *1* relay. If the DIP switch is set to *Zone 1 Heat*, the control follows a similar procedure as above to test the zone *1* relay. If the DIP switch is set to *Zone 1 Cool*, the control will also turn on the zone *1* relay for 10 seconds.

Step 12 - After the test sequence is complete, the *Test* light begins flashing and the control enters a fast mode of operation. During this time, the control is much more responsive to setting adjustments. If the dial on an RTU is turned up, the zone relay should turn on immediately. After fifteen minutes, the control reverts back to normal operating conditions and the zone on times are based on the average indoor temperatures during the previous 15 minute cycle.



Manual Test

While the control is in the fast mode of operation and the Test light is flashing, check that each RTU operates the proper zone valve or zone pump. Turn up the RTU dial to turn the zone on, turn the dial down to turn the zone off. If an Indoor Sensor is used, a cold spray to the sensor will turn the zone on.



Adjusting RTU settings provides an immediate response for the first 15 minutes only.

Indicator Lights "On"

Power • 120 V (ac) power is applied to the control and the control is energized.

DHW Demand • The DHW tank is requesting heat.

Setpoint Demand • Setpoint operation is required.

WWSD • Heat is not required in the heating system.

Maximum Supply • The supply temperature is approaching the *Max. System Supply* dial setting and the 371 will not increase the supply temperature any further.

Minimum Boiler • The supply temperature from the boiler is below the *Min. Boiler Supply* dial setting and the 371 is reducing the load on the boiler in order to increase the boiler supply temperature as fast as possible.

DHW Pmp • The relay contacts between *DHW Pmp — Power L (*4 and 22) are closed and the DHW pump should be running.

System Pump 2	• The relay contacts between *Sys P2—Power L* (1 and 4) are closed and the mixing system pump (P2) should be running.
System Pump 1	• The relay contacts between *Sys P1—Power L* (2 and 4) are closed and the boiler system pump (P1) should be running.
Boiler	• The relay contacts between *Boiler — Boiler* (20 and 21) are closed and the boiler should be turned on.
Zone 5 / Close	• The relay contacts between *Com 3-4— Cls 5* (28 and 31) are closed and the device connected to this relay should be turned on. If a mixing valve is used, it should be closing.
Zone 4 / Open	• The relay contacts between *Com 3-4— Opn 4* (28 and 30) are closed and the device connected to this relay should be turned on. If a mixing valve is used, it should be opening.
Zone 3	• The relay contacts between *Com 3-4— 3* (28 and 29) are closed and the device connected to this relay should be turned on.
Zone 2	• The relay contacts between *Com 1-2— 2* (25 and 27) are closed and the device connected to this relay should be turned on.
Zone 1 / Cool	• The relay contacts between *Com 1-2— 1* (25 and 26) are closed and the device connected to this relay should be turned on.
% of full output lights	• These lights indicate the percentage of full speed the variable speed injection pump is operating at.
Test	• The control is proceeding through the programmed test sequence.
Occupied	• The control is in Occupied mode.
UnOccupied	• The control is in UnOccupied (Night Setback) mode.
Optimum Start / Stop	• The control is warming the building up during the final stages of the UnOccupied period, or the heating system is turned off during final stages of the Occupied period.
Timer Active	• The timer is set to enter the UnOccupied mode every 24 hours at the time of the day the *Start* button was pressed.

STEP EIGHT — TROUBLESHOOTING

As in any troubleshooting procedure, it is important to isolate a problem as much as possible before proceeding. The Error Messages and *Test* button greatly simplify troubleshooting of the 371. When the control is flashing an Error Message, identify the fault from the look-up table on page 19 and follow standard testing procedures to confirm the problem. If you suspect a wiring fault, return to steps three, four and five, and carefully check all external wiring and wiring connections.

Sensor and Internal Faults

- If an Outdoor Sensor fault occurs, the 371 assumes a fixed outdoor temperature of 32°F (0°C) and will regulate the supply water temperature accordingly. An error message is displayed.
- If an RTU / Indoor Sensor fault occurs or the Zone Control input *Zo - in* short circuits, the 371 operates as if that RTU or Zone Control is not connected. An error message is displayed.
- If the enclosure overheats, the 371 turns off the variable speed injection pump and displays an error message until it cools off.
- If an internal control fault occurs, the 371 displays an error message. Press the *Test* button to clear the error message. If the error message remains, the control must be returned for repair.
- If a Supply Sensor fault occurs, the 371 displays an error message and turns the variable speed injection pump off. If a mixing valve is used, the control closes the valve.
- If a Boiler Sensor fault occurs, the 371 displays an error message and turns the *Boiler* relay off.

During Floating Operation

- If an RTU is connected to zone 4 and the zone 4 DIP switch is set to *Boiler*, the control displays an error message.
- If an RTU is connected to zone 5 and the zone 5 DIP switch is set to *Boiler*, the control displays an error message.

Adjustment of Heating Curve Settings

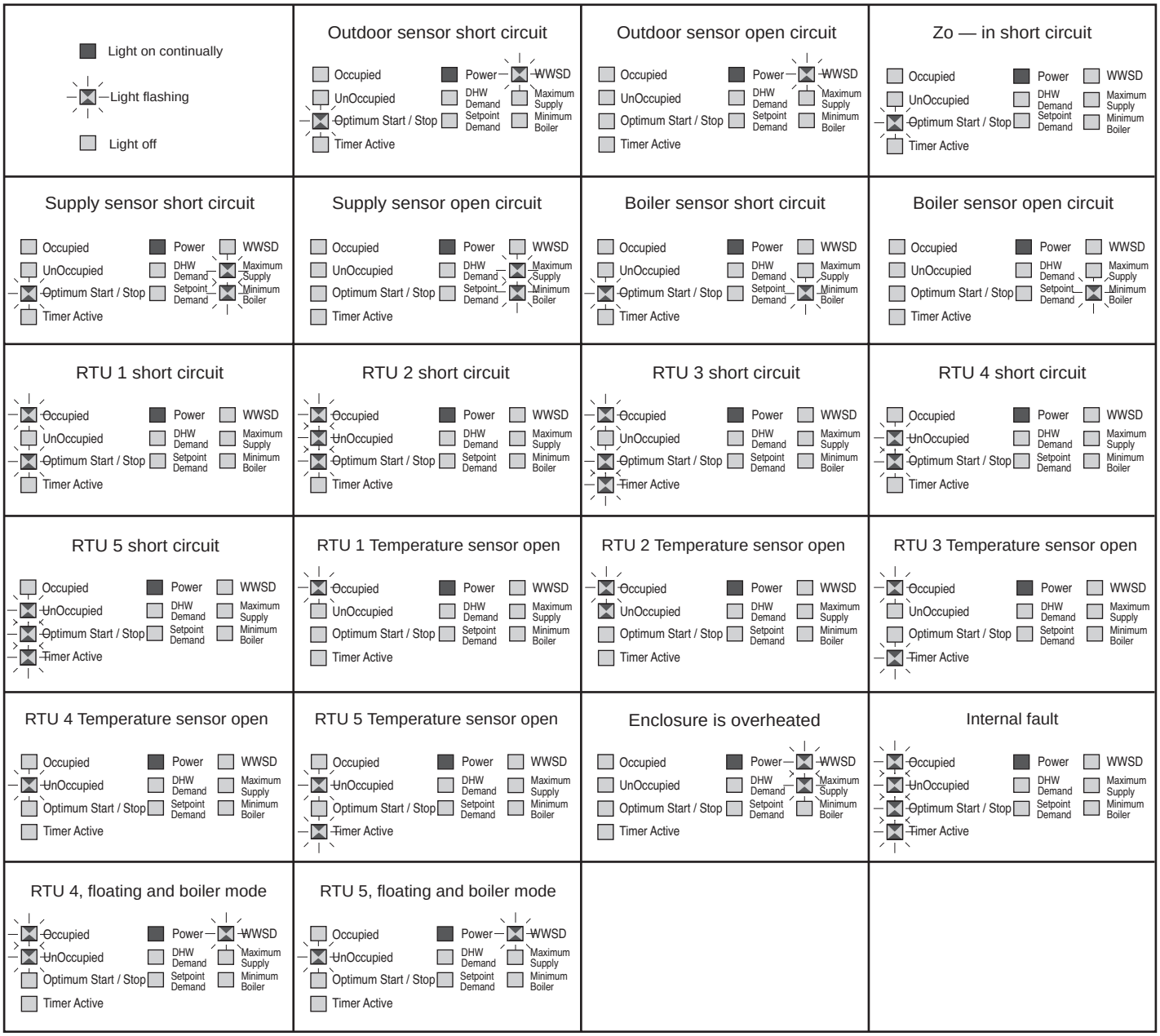
- If the outdoor air temperature is cold and the RTU dials are set properly, but the boiler zones are cold, increase the *Boiler Heating Curve* dial setting by 1/2 an increment segment per day.
- If the outdoor air temperature is cold and the RTU dials are set properly, but the mixing zones are cold, increase the *Heating Curve* dial setting by 1/2 an increment segment per day.

STEP NINE — BEFORE YOU LEAVE

- Install the wiring cover over the wiring chamber and secure it to the base with the two screws provided. Place the front cover on the control and snap it into place. Install a lock if security is required.
- A sticker has been provided with the control. It is designed to be placed over the *Zone 1...Zone 5* words so that the zone names can be written onto the control.
- Place this brochure, and all other brochures related to the installation, in the protective plastic bag supplied with the control. Place the bag in a conspicuous location near the control for future reference.
- It is important to explain the operation of the control to the end user and to anyone else who may be operating the system.

Error Messages

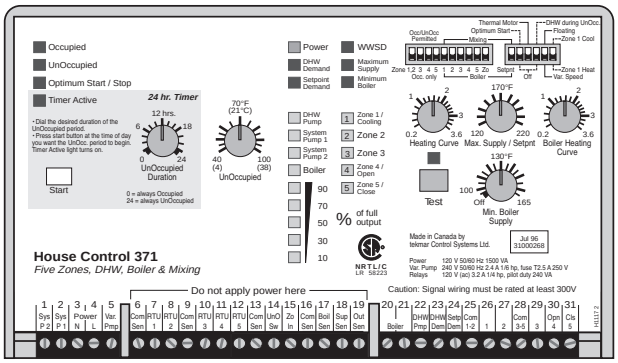
Whenever a fault is detected in any of the sensors and / or room temperature units (RTUs), the indicator lights will flash in specific ways to indicate the location of the problem. For detailed Sensor and RTU testing instructions see Data Brochures D 074 and D 054.



Technical Data

House Control 371 *Five Zones, DHW, Boiler & Mixing*

Literature	—	A 000, A 371's, I 030, E 021, D 371, D 001, D 054, D 070, D 074
Control	—	Microprocessor PID control; This is **not a safety (limit) control**.
Packaged weight	—	3.5 lb. (1600 g), Enclosure A, PVC plastic
Dimensions	—	6-5/8" H x 7-9/16" W x 2-13/16" D (170 x 193 x 72 mm)
Approvals	—	CSA NRTL / C, meets ICES & FCC regulations for EMI/RFI.
Ambient conditions	—	Indoor use only, 32 to 122°F (0 to 50°C), < 90% RH non-condensing.
Power supply	—	120 V ±10% 50/60 Hz 1500 VA
Variable Pump	—	240 V 50/60 Hz 2.4 A 1/6 hp, fuse T2.5 A 250 V
Relays	—	120 V (ac) 3.2 A 1/4 hp, pilot duty 240 VA
Demand inputs	—	Off @ 0 to 5 V (ac), On @ 15 to 120 V 50/60 Hz 0.6 VA
Sensors	—	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) ß=3892
included:		Outdoor Sensor 070 and two of Universal Sensor 071.
required:		RTU 054, 055 or 10K Sensor for each active zone. (Order separately)
Timer	—	24 hour, 1 event / day, 3 minute backup
UnOcc. Duration	—	0 to 24 hours
UnOccupied	—	40 to 100°F (4 to 38°C)
Heating Curve	—	0.2 to 3.6
Max. Supply / Setpoint	—	120 to 220°F (49 to 104°C)
Boiler Heating Curve	—	0.2 to 3.6
Min. Boiler Supply	—	Off, 100 to 165°F (Off, 38 to 74°C)



The installer must ensure that this control and its wiring are isolated and/or shielded from strong sources of electromagnetic noise. Conversely, this Class B digital apparatus complies with Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Regulations. However, if this control does cause harmful interference to radio or television reception, which can be determined by turning the control off and on, the user is encouraged to try to correct the interference by reorienting or relocating the receiving antenna, relocating the receiver with respect to this control, and/or connecting the control to a different circuit from that to which the receiver is connected.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Caution The nonmetallic enclosure does not provide grounding between conduit connections. Use grounding type bushings and jumper wires.

Attention Un boîtier nonmétallique n'assure pas la continuité électrique des conduits. Utiliser des manchons ou des fils de accord spécialement conçus pour la mise á la terre.

Limited Warranty and Product Return Procedure

Limited Warranty ***The liability of tekmar Control Systems Ltd. and tekmar Control Systems, Inc. ("tekmar") under this warranty is limited. Please read and understand the conditions appearing herein.***

tekmar warrants each tekmar product against defects in workmanship and materials, when the product is installed and used in compliance with tekmar's instructions. The warranty period is for a period of twenty-four (24) months from the production date if the product is not installed during that period, or twelve (12) months from the documented date of installation if installed within twenty-four (24) months from the production date, but in any event the warranty period shall not extend beyond thirty-six (36) months from the production date. During the warranty period, tekmar will, at its discretion, either repair at no charge, exchange or give credit for the defective product, provided the product is returned to tekmar.

The liability of tekmar shall be limited to the cost of parts and labour provided by tekmar to correct defects in materials and / or work-manship or to the exchange of the defective product for a replacement product or to the granting of credit limited to the original cost of the product, at tekmar's discretion, and such repair, exchange or credit shall be deemed to be the sole remedy available from tekmar. This warranty does not cover the cost of the parts or labour to remove or to transport the defective product, or to reinstall the repaired or replacement product. Returned products that are not defective are not covered by this warranty.

This warranty does not apply if the product has been damaged by accident, abuse, misuse, negligence, fire, Act of God, or has been damaged by modifications, alterations or attachments made subsequent to purchase which have not been authorized by tekmar, or if the product was not installed in compliance with the local codes and ordinances, or if due to defective installation of the product.

The warranty applicable to a product is as set out in the statement of warranty policy (the "Warranty") above, receipt of which is hereby acknowledged. The liability of tekmar is limited to those obligations identified in the warranty as obligations of tekmar. The warranty is understood to be in substitution for any loss, costs or damages for which tekmar might otherwise be liable at law or in equity and in particular, in lieu of any liability for fundamental breach of contract.

tekmar disclaims any responsibility for losses, expenses, inconveniences, or any special, indirect, secondary, incidental or consequential damages arising from ownership or use of any items subject to any claim hereunder, regardless of whether such claim is stated in contract, tort or strict product liability.

This warranty is in lieu of all other warranties, express or implied, including, without limitation, warranties of merchantability, fitness for a particular purpose, durability or description of the product, its non-infringement of any relevant patents or trademarks, and its compliance with or non-violation of any applicable environmental, health or safety legislation. No implied warranties shall extend beyond twenty-four (24) months from the production date.

Some states or provinces do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state or province to province.

Product Return Procedures Products that are believed to have defects in workmanship or materials must be returned, together with a written description of the defect, to the tekmar representative for that territory. If the address of the representative is not known, please request it from tekmar at the telephone number listed below.

tekmar® Control Systems

tekmar Control Systems Ltd., Canada
tekmar Control Systems, Inc., U.S.A.
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Vernon, B.C. Canada V1B 3K4
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