

DCS-3000 AutoCure

Operating Manual

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1. OVERVIEW

The DCS-3000 AutoCure is a Supervisor Control System¹ designed to cure tobacco while requiring little operator intervention, yet giving him full control. In this technique the kiln fan runs continuously but the furnace fires only when the temperature difference between the top² and bottom³ of the kiln is less than a specified amount.

Initially with wet, tightly packed tobacco it is difficult for air to pass through the tobacco and the the temperature at the bottom of the kiln rises faster than at the top of the kiln. When the temperature difference between the top and bottom is greater than 5° (step 1) or 15° (step 2)⁴ the furnace quits firing but the fan continues to run. As air circulation continues the top and bottom temperatures will approach each other and the furnace will fire again.

With a freshly loaded kiln, the temperature advances slowly but as the tobacco dries air passes from the bottom to the top more readily and the furnace will automatically fire longer and the kiln temperature will advance faster. Tobacco should cure faster and more uniformly with less operator interaction than with the advance and hold method which requires an operator to estimate several times during a cure the rate that the temperature should advance.

YELLOWING and DRYING

- Two step process, the first is yellowing and the second is drying.
- The wet bulb is controlled automatically
- The advance rate is determined automatically.
- During yellowing and drying little or no operator intervention is required although at all times the operator can make changes either locally or via a remote PC.
- In order to ensure quality tobacco the controller holds kiln conditions steady when yellowing conditions are reached until the operator decides that yellowing is complete and the kiln should start drying.
- Once drying begins the controller again advances automatically to a predetermined end temperature.

REMOTE CONTROL⁵

DCS-3000 systems can be upgraded to be monitored and controlled remotely over a telephone line when the available software and hardware module are added.

- Software allows a farmer to see an overview of up to 253 kilns in one yard. Kilns requiring action are highlighted to draw the operator's attention. The farmer can select a particular kiln and see on his computer screen the status of that kiln. He can then change the status of that kiln.
- A new hardware interface unit, the DCS-IU, connects up to 253 kilns to one telephone line.

CASING

Before casing the first kiln of tobacco the operator enters the dry and wet bulb temperatures as well as the duration of casing he wants. The DCS-3000 will then automatically control the casing process. Again the operator can allow completely automatic operation of this step or view and change conditions at any time.

¹ *Supervisory control* the controlled machine or process continues autonomously. It is observed from time to time by a human who, when deeming it necessary, intervenes to modify the control algorithm in some way. Wikipedia

² Return Air or Delta T temperature

³ Supply Air or Dry Bulb Temperature

⁴ These are default temperatures. They be changed by the operator and will be remembered by the controller once changed.

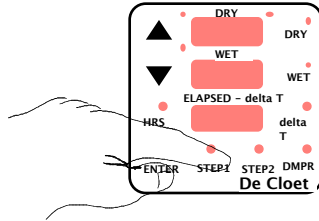
⁵ See separate Computer Interface Manual

2. OPERATION

STAND-BY

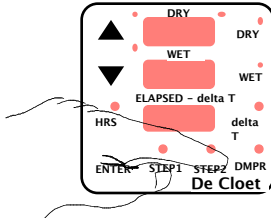
As long as power is applied to the DCS-3000 the dry bulb temperature of the kiln is indicated on the upper display. If the other displays are blank the unit is NOT controlling the kiln and is said to be in stand-by mode.

YELLOWING



Press and hold the STEP1 button for about 5 seconds until the middle and lower displays light. While the unit operates the light in the STEP 1 button remains lit, the actual dry bulb temperature, the actual wet bulb temperature and the elapsed time displays will be on. The elapsed time counter is set to zero when STEP 1 is pressed. Use the set point keys to change the factory values if desired.

DRYING



When you are satisfied the yellowing process is complete press and hold the STEP 2 button until the STEP1 light goes off. The STEP2 light will turn on, the dry bulb temperature, wet bulb temperature and elapsed time displays will display. Use the set point keys to change the factory values if desired

NOTE:

The DCS will only call for heat during YELLOWING and DRYING if all the following conditions are met:

- the dry temperature is below or equal to the dry setpoint
- the dry temperature is not more than the delta T setpoint value above the delta T temperature⁶
- the dry temperature is not more than 10 degrees below the delta T temperature⁷

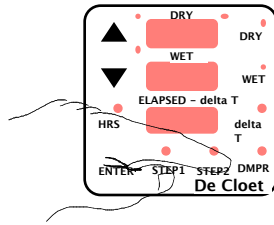
DAMPER OPERATION

If the actual wet bulb temperature is below the set point the damper will remain closed. As soon as the wet bulb temperature exceeds its set point the damper will begin to open gradually until it is fully open when the actual temperature reaches the set point plus 2 1/2 degrees. This allows moisture to be exhausted from the kiln.

⁶ This allows the temperature to rise faster as the tobacco dries and allows more air to pass through while at the same time prevents tobacco near the floor from being overheated. It is also a safeguard to prevent a runaway kiln should one of the temperature sensors be mechanically damaged and report false readings.

⁷ Normally the top of the kiln, where the delta T sensor is located, will be cooler than the floor where the dry bulb temperature sensor is located, and where heat is introduced. However, this condition allows the furnace to fire at startup on a hot day when the sun could have heated the air space above the tobacco bins. If the ceiling is even more than 10 degrees warmer than the floor the fan will continue to run until the circulating air has lowered the ceiling temperature.

STOPPING THE CURE



At the end of the cure press STEP2 for about 5 seconds until the red light goes out. This will reset the clock, so that you are ready for the next cure.

SET POINT KEYS

There are set point keys, labelled DRY, WET, delta T to easily view and change any individual set point. While the program is running depress any set point key to display the set point value. To change the value, keep the key depressed and use the arrow keys to select the desired value. The program is now updated. Pressing the DAMPR key will display the damper percent opening. This can not be changed.

The 10 degree alarm works as a high alarm. It does not monitor low temperatures.

The DCS-3000 is delivered preprogrammed with the following values.

YELLOWING STAGE

dry bulb set point	100 °F
wet bulb set point	100 °F
delta T set point	5 °F

DRYING STAGE

dry bulb set point	155 °F
wet bulb set point	100 °F
delta T set point	15 °F

Any changes to these values entered by the operator during one cure will be remembered by the instrument and used by it as the default values for the next cure.

AUTO DAMPER CONTROL

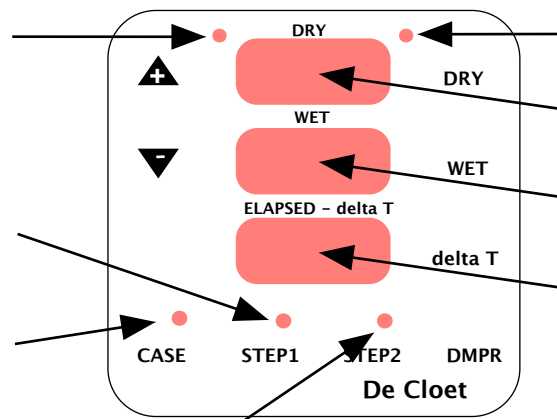
Auto damper control is active at all times.

WHAT THE KEYBOARD LIGHTS MEAN

If lit the dry or wet bulb temperature is 10 deg Fahrenheit or more above the set point.

If lit the instrument is controlling STEP1 of a cure cycle.

If lit the instrument is controlling the casing process.



If lit the instrument is calling for heat.

Dry bulb temperature, Setpoint when DRY pressed

Wet bulb temperature' Setpoint when WET pressed

This display normally indicates elapsed hours . It indicates the delta T setpoint when the delta T button is depressed. It indicates delta T actual when CASE is pressed

If lit the instrument is controlling STEP2 of a cure cycle.

WHAT THE BUTTONS DO

Increase value displayed when DRY, WET, RATE or DMPR buttons are pressed.

Decrease value when DRY, WET or delta T buttons are pressed.

Press STEP1 to start a cure. The DCS-3000 remembers the setpoints from the last cure. You can check the setpoints by pressing the DRY, WET or delta T keys. This step will control the cure up to the yellowing stage.

1. While in Standby Press 5 sec to start casing.
2. While in Casing Press 5 sec to stop casing.
3. While in STEP1 or STEP2 Press for temperature of delta T sensor.

Press STEP2 to complete a cure. The DCS-3000 remembers the set points from the last cure. You can check the set points by pressing the keys on the right side. This step will control the cure from yellowing to completion.

Press and hold here while pressing the arrow keys to change the DRY temperature set point.

Press and hold here while pressing the arrow keys to change the WET set point.

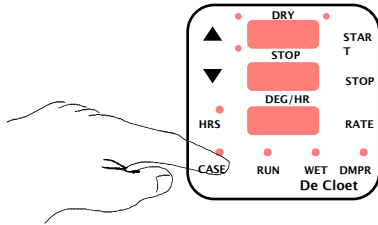
Change the number of degrees the top and bottom of the kiln can be apart and still have the furnace fire

Press and hold here to see the damper position displayed in %

3. Casing⁸

TO BEGIN CASING

From STANDBY press and hold the CASE button for 5 seconds until the light above this button remains on. This time delay is intentional to prevent casing beginning accidentally. Once a casing cycle is started it can be stopped by pressing the same CASE button for 5 seconds. Again this time delay prevents casing from being accidentally stopped.



While the unit operates, the light in the CASE button remains lit, the upper display indicates the dry bulb, the middle display indicates the wet bulb and the lower display counts down the time remaining in the casing cycle. A dry bulb temperature of 122F and wet bulb temperature of 113F are automatically set by the instrument when the CASE key is used the first time. These values can be easily changed and the instrument will remember and use the most recent values when starting the next casing cycle. An elapsed time of 8 hours will be set by the DCS-3000 each time a casing cycle is started. This duration can be changed for the current cycle. The new value will not be stored for future cycles.

When the CASING cycle is started.:

- the humidity relay is deactivated
- the 10 degree dry bulb window alarm is deactivated
- the fan will turn on
- the furnace relay will operate as required to reach the dry bulb setpoint
- if the actual dry bulb temperature is greater than the dry bulb setpoint.
 - the damper will open fully
- if the actual dry bulb temperature is less than the dry bulb setpoint.
 - the damper will close fully

When the actual dry bulb temperature reaches its setpoint

- the damper will close fully
- the 10 degree dry bulb window alarm is activated
- the humidification relay will activate to maintain a wet bulb of 113F or the value specified by the operator by closing the normally open humidity relay when the wet bulb temperature drops below its setpoint.
- the gas valve will be controlled to maintain the dry bulb setpoint.
- the dry and wet bulb temperatures will be held at their setpoints for 8 hours or for as long as specified by the operator.

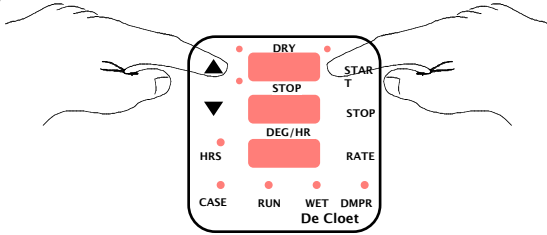
When the timer counts down to 0

- the damper will stay closed
- the fan will shut off
- the burner, humidity and 10 degree alarm relays will be de-activated
- the timer will continue to count down to 1.0 hours or until the CASE button is held down for 5 seconds

⁸ this feature requires multi-function board

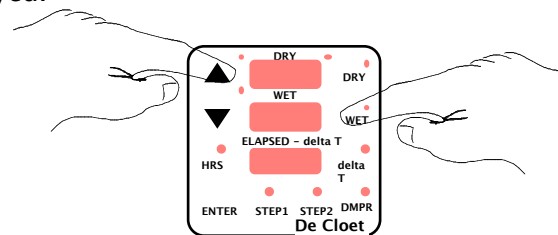
TO CHANGE CASING DRY BULB TEMPERATURE

Hold the “DRY” button down and at the same time press an arrow key until the desired new temperature is displayed.



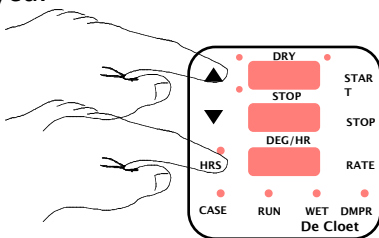
TO CHANGE CASING WET BULB TEMPERATURE

Hold the “WET” button down and at the same time press an arrow key until the desired new temperature is displayed.



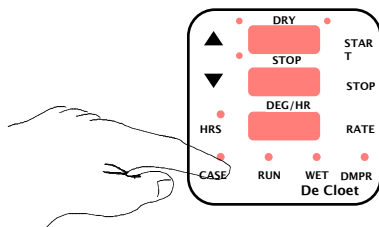
TO CHANGE CASING DURATION

Hold the “HOUR” button down and at the same time press an arrow key until the desired new time is displayed.



TO STOP A CASING CYCLE

Hold the CASE button for 5 seconds until the light in this button turns off.



NOTE 1: The DCS-3000 remembers the wet and dry bulb casing setpoints from run to run and uses the last values as the default. The casing duration can be changed for a run, but will reset to 8 hours for the next run.

NOTE 2: Once the dry bulb set point is reached the casing humidity relay will call for humidity when the actual wet bulb drops below set point. This will only have an effect if a water supply and the casing wand are connected.

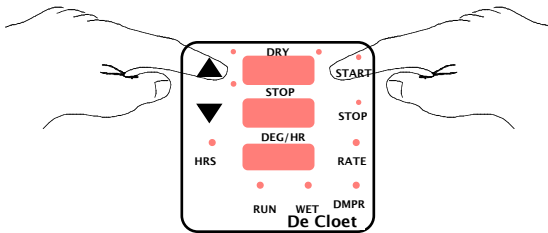
4. SET-UP (Changing the way the instrument works)

The DCS-3000 is normally delivered preprogrammed and you will not need to use this section.

If you want to change how the DCS-3000 operates these instructions tell you how to:

- Specify how many seconds to wait before starting the fan motor after a power failure⁹
- Specify the beginning of range temperature you can set in run mode
- Set an identification number for the instrument if using the communications features
- Set a correction to the pulsing rate
- Apply temperature correction to the RTD temperature sensors
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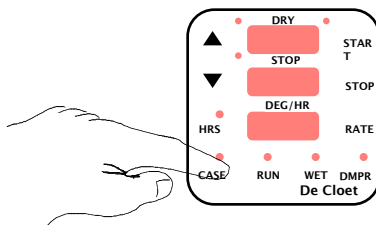
Press and hold the UP arrow and DRY keys for 10 seconds



Software identification: After 10 seconds has elapsed and as long as you continue to hold the two keys the top display will read 308, the middle display will read r30 and the bottom display will read dt. This information is helpful to our technicians.

Display check: Once you release the keys all numeric and LED displays will cycle continuously. This is used to verify all display segments are operating properly. Once you are happy all display segments are operational

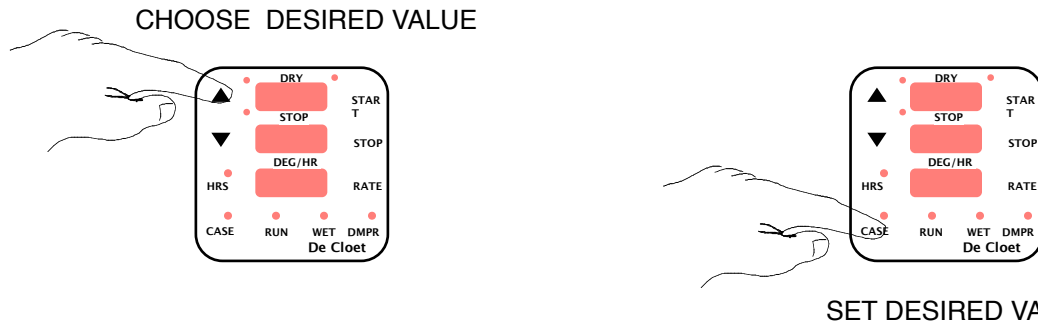
Press the key in the lower left corner



Do this to move from step to step in the set-up process

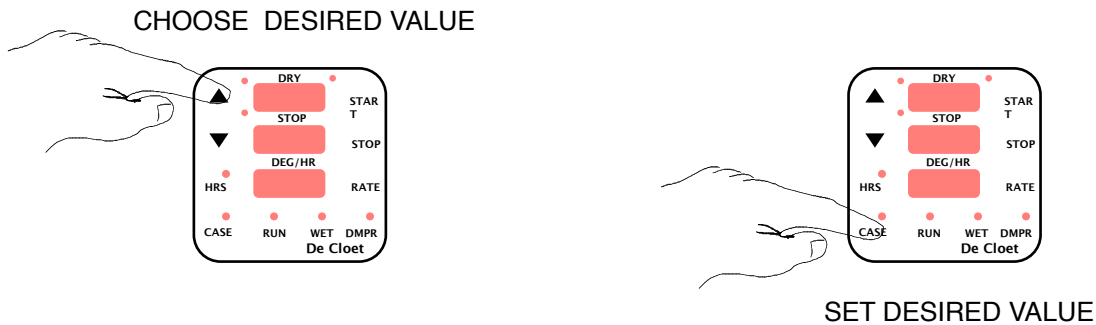
⁹ this feature requires multi-function board

Choose fan motor startup time delay:



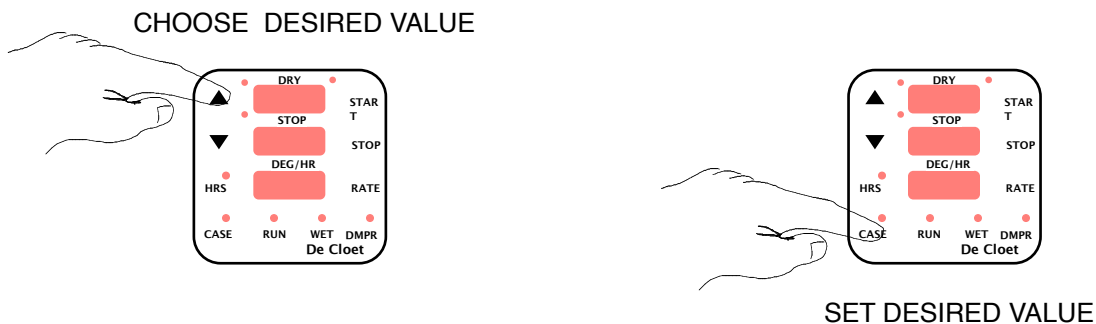
To prevent circuit over loads when starting several kilns on the same power line after a power failure a time delay can be programmed to stagger the starts of individual kilns. The top display shows “FAN”, the middle display shows dLy and the lower flashes the number of seconds the fan start up will be delayed. Choose the desired value with the arrow keys. Press the lower left unmarked key to set this value. This delay only applies to start after a power failure. On manual start the fan will start immediately. If you do not have the multi-function board set this value to zero since the instrument will prevent the furnace from firing until the set time has elapsed.

Choose start temperature of operating range:



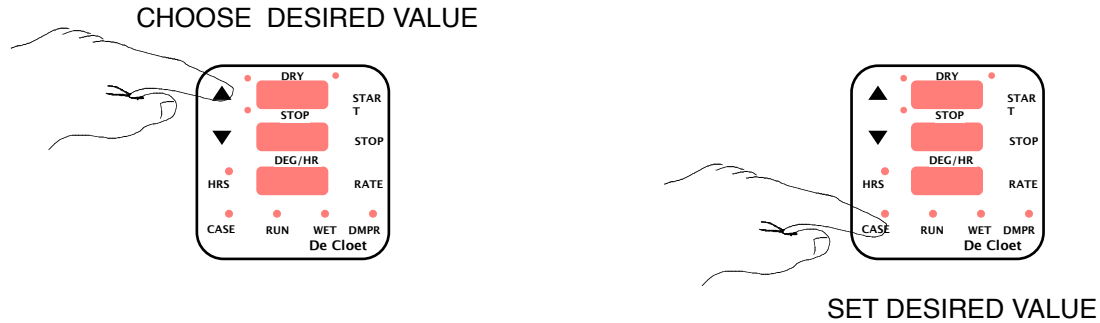
The top display shows “Str” and the middle display flashes a number from 32 to 112. Choose the desired value with the arrow keys. Press the lower left unmarked key to set this value. The operating range will always be 100 Fahrenheit degrees. It will normally be from 70 to 170.

Choose instrument ID:



If several DCS-3000’s are connected to a computer you will need to uniquely identify each DCS-3000. In SETUP mode a 3 digit identification number can be assigned to each DCS-3000. The top display will read 1d, meaning identification. Choose the desired value with the arrow keys. Press the lower left unmarked key to set this value between 1 and 253.

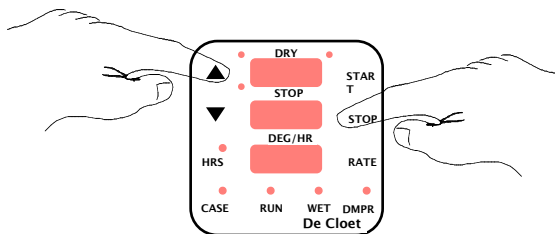
Changing the Aqua-Stat pulse rate



It is no longer necessary to manually adjust a knob on the front of the Aqua-Stat. The Aqua-Stat pulse rate is controlled by the DCS-3000 and automatically pulses faster as the temperature increases in the kiln. However, if the default value of 100 is either too slow and the wet bulb dries out or is too fast and the water reservoir empties too quickly the rate can be changed here. The default set at the factory is 100%. You can adjust this value in 1% increments down to 50% to decrease the time between pulses. This will increase the amount of water going to the wet bulb if it was drying out too quickly. You can also adjust this value in 1% increments up to 200% which will increase the time between pulses and use water less quickly.

The top display will read AqA for Aqua-Stat. The bottom display will read a value from 50 to 200. Press either arrow key to choose the value you want. When the desired value is displayed press the lower left key to set the value.

Apply temperature correction:



The displayed temperature of each of the three RTD sensors can be offset¹⁰ here by up to plus or minus five degrees Fahrenheit. Hold the button to the right of the display to be offset and use the arrow keys to apply a correction. The DCS-3000 will not display temperatures above 185, so boiling water can not be used. Instead, immerse sensors in a bucket of ambient temperature water along with an accurate thermometer if you wish to verify the temperature accuracy or apply a correction.

¹⁰ Temperature correction should rarely be necessary as this system uses platinum RTD sensors. These sensors are widely used in industrial applications where long term accuracy and stability are critical. Rare failures are normally the result of mechanical damage requiring sensor replacement.

5. DEFAULT VALUES

The standard unit will be delivered preprogrammed and ready for operation with the following variables preset.

- Temperature displays will be in Fahrenheit
- The temperature control switching differential will be set to 0.7 degrees
- The beginning of range set point, SPL, will be set to 70
- The motor start time delay will be set to 10 seconds
- The instrument ID will be set to 000
-
- The delta T STEP1 dry bulb will be set to 100F
- The delta T STEP1 wet bulb will be set to 100F
- The delta T STEP1 differential will be set to 5F
- The delta T STEP2 dry bulb will be set to 155F
- The delta T STEP2 wet bulb will be set to 100F
- The delta T STEP2 differential will be set to 15F
-
- The casing dry bulb temperature will be set to 122F
- The casing wet bulb temperature will be set to 113F
- The casing time will be set to 8 hours

6. ALARMS

The High alarm will be active while the unit is in STEP1 or STEP2.

1. If either the wet or dry bulb is 10 degrees above its corresponding set point an alarm relay will be closed. This relay can be wired into an external annunciator.
2. An LED to the left of the dry bulb display indicates a high temperature alarm.

7. TROUBLE SHOOTING

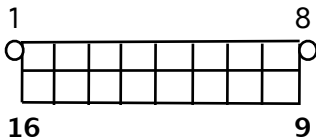
The unit will not power up if:

- The air pressure switch does not detect the fan running.
- An on/off toggle switch has been installed and is in the OFF position

The unit will not call for heat if:

- The set point alarm temperature is 10 degrees F or more above the dry bulb set point.
- The high alarm temperature is above its set point which can be set to 150,200 or 250F. In this case the relay will latch open and can be reset by pushing the button on the multi-function board after the temperature has dropped.

8. CONNECTIONS



The above view is from the back of the DCS-3000-A controller

1. 24 VAC1
2. Ground
3. +5V for Comms
4. Gas valve (N.O.)
5. Gas valve common
6. Gas valve (N.C.)
7. Alarm relay common
8. Damper output (2-10 VDC)
9. Temperature Set point logic signal to multi-function board
10. Alarm relay (N.C.)
11. Alarm relay (N.O.)
12. Humidification control logic signal to multi-function board
13. Comms Receive
14. Comms Transmit
15. Fan control logic signal to multi-function board
16. 24 VAC2

9. COMPATIBILITY WITH PREVIOUS VERSIONS

DCS-3000 front boards and multi function boards manufactured recently can be upgraded to AutoCure units. You can see if a DCS-3000 controller can be upgraded by checking its *Software Identification*. To do this see section 4. If the first digit on the top display is a 2 or 3 the instrument can be upgraded. Most commonly the top display will read 201 or 308 on versions that can be upgraded.

10. AQUA-STAT PULSING RATES

The DCS-3000 increases the Aqua-stat pulsing rate as the actual dry bulb temperature increases to ensure accurate wet bulb temperatures at higher temperatures.