SECTION 3

THEORY OF OPERATION

CONTROL PANEL

This page shows the control panel layout (See Figure 3-1) and explains the functions performed at the control panel

POWER Button (Green Indicator Light)

Pressing the POWER button once will activate the ice machine and green POWER light.
Pressing the POWER button a second time will de-activate the ice machine.

Automatic Ice Making Light (Blue Indicator Light)

The ICE light is illuminated when the ice machine is in the ice making position. The light is off when the ice machine is in the clean cycle.

DELAY Start

Pressing the DELAY button will initiate a delay cycle. The ice machine will not run until delay time expires.

1. Pressing the button once will illuminate the "2" hour yellow light and initiate a two hour delay period.
2. Pressing the button a second time will illuminate the "4" hour yellow light and initiate a four hour delay period.
3. Pressing the button a third time will illuminate the "8" hour yellow light and initiate an eight hour delay period.
4. Pressing the button a fourth time will cancel the delay cycle.

CLEAN Button (Green Indicator Light)

Pressing the CLEAN button will initiate a clean cycle and de-activate the ICE light. The water system will enter a fill/flush mode for approximately ninety (90) seconds, after which the CLEAN light will flash to indicate the proper time to add ice machine cleaner or sanitizer.

REPLACE FILTER (Red Indicator Light)

When the ice machine completes 8000 freeze/harvest cycles the light will illuminate to indicate the filter needs replacement. Depressing the CLEAN button for 6 seconds will reset the counter and light.

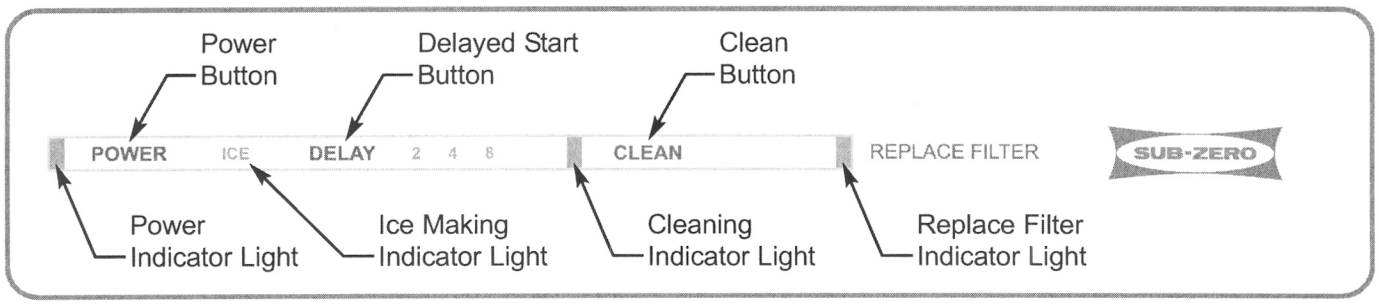

Figure 3-1. Control Panel Layout

OPERATING SYSTEMS

There are three operating systems in the ice machine:

- *Refrigeration System*
- *Water System*
- *Electrical (Electronic Control) System*

Refrigeration System

The following components have been listed in the order of refrigerant flow, with an explanation of their function as part of the refrigeration system. (See Figure 3-2)

- **Compressor:** The compressor creates a high side and low side pressure difference in the refrigeration system by compressing the refrigerant gas, thus raising the pressure and temperature. During the ice making cycle the compressor pushes this high-pressure/high-heat gas to the condenser.
- **Condenser:** The high-pressure/high-heat gas travels through the condenser, where the heat is dissipated by cooler air being drawn over the condenser tubing by the condenser fan. This changes the gas into a high-pressure/warm liquid that then enters the filter-drier.
- **Filter-Drier:** The high-pressure/warm liquid travels through the filter-drier, which removes moisture from the refrigerant before it enters the capillary tube.
- **Capillary Tube:** The warm liquid refrigerant travels through the skinny capillary tube which is attached to the suction tube and wrapped around the base of the accumulator. As the warm liquid refrigerant travels through the capillary tube it gives up heat to the cool vapor refrigerant in the accumulator and to the cool refrigerant gas traveling through the suction line. As the refrigerant in the capillary tube gives up heat, the pressure drops, so it is a low-pressure/cool liquid before it enters the evaporator.
- **Evaporator:** A dramatic pressure drop occurs as the low-pressure/cool liquid refrigerant leaves the small diameter capillary tube and enters the larger diameter evaporator tubing, and the refrigerant begins to vaporize. This vapor travels through the evaporator absorbing heat from the water being sprayed on the evaporator. This cool vapor then enters the accumulator.
- **Accumulator:** Another pressure drop occurs as the cool vaporized refrigerant leaves the evaporator tubing and enters the larger diameter accumulator tubing. Any liquid or vaporized refrigerant that may remain at this point is converted to gas. The capillary tube is wrapped around the accumulator base to give up heat to the refrigerant in the accumulator before it enters the suction line.

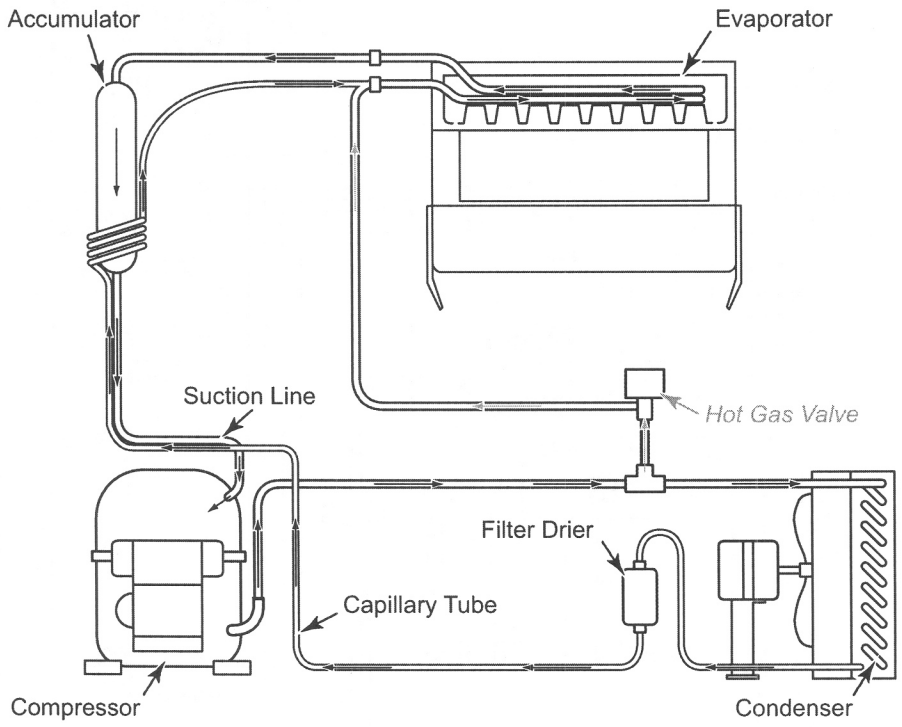

Figure 3-2. Refrigeration System *(During Ice Making Cycle)*

- **Suction Line:** The cool gas travels through the suction line, absorbing heat from the warm liquid refrigerant traveling through the capillary tube. This assures that it is a luke warm gas before it enters the compressor, where the process begins again.

NOTE: *There is an additional component in the ice machine refrigeration system which is used during the harvest cycle, this component is called the hot gas solenoid valve. Its function is described below:*

- ***Hot Gas Valve:*** *During a harvest cycle, the hot gas solenoid valve interrupts the flow of high-pressure / high-heat gas from the compressor, diverting it past the condenser, filter-drier and capillary tube, directly to the evaporator. This high-pressure/high-heat gas warms the evaporator so that the ice cubes release from the cube molds.*

Water System

The water system provides and recirculates the water for ice production. It also provides a means of drainage. After the ice is produced, the water system flushes the impurities and minerals that were in the water, down the drain. (See Figure 3-3)

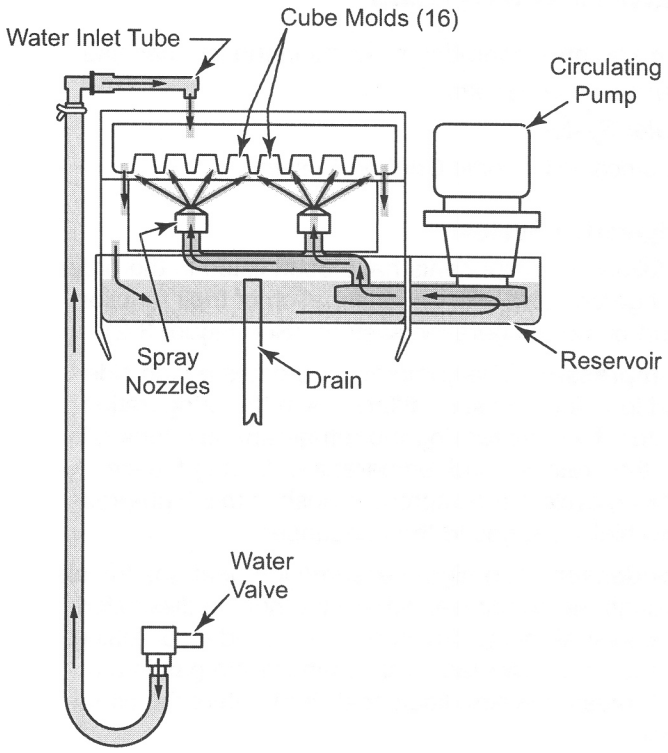

Figure 3-3. Water System *(Beginning of Ice Making Cycle)*

Electrical (Electronic Control) System

Power for the refrigeration system and the water system in the model UC-15I is provided through the electronic control system. The electronic control system also regulates the operational cycles of the ice machine. Refer to the Wire Diagram at right (See Figure 3-4).

NOTE: *The models UC-15IP and UC-15IPO have a drain pump that is powered off of L1, so even when the ice machine is switched OFF, the pump can continue to pump melted ice water to the drain.*

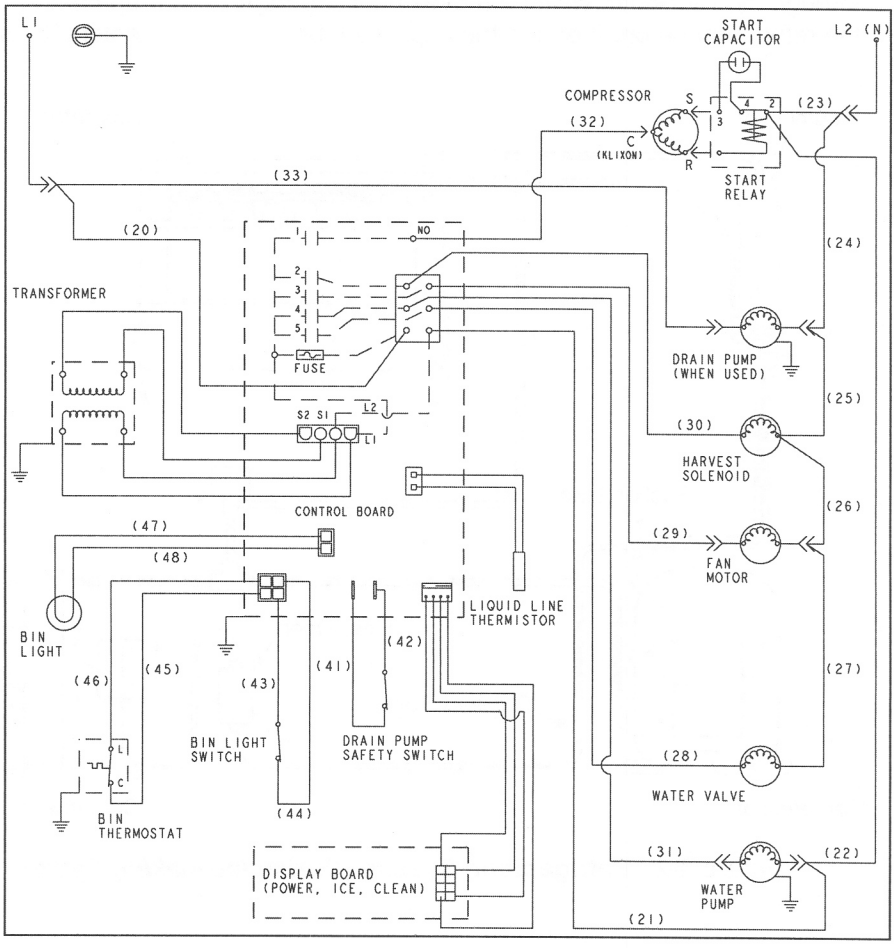

Figure 3-4. Electrical System Wire Diagram

SEQUENCE OF OPERATION

The Sequence of Operation table below provides a quick overview of the different operational events that the ice-maker will experience under normal conditions. Following the table, wire diagrams are used to illustrate which components are energized during each event and additional information is provided. For the freeze cycle and the harvest cycle, diagrams of the water system and refrigeration system are included to help illustrate what is happening inside the ice machine during those cycles.

SEQUENCE OF OPERATION						
SEQUENCE (EVENT) (RELAY)	**Water Pump** (4)	**Water Inlet Valve** (5)	**Hot Gas (Harvest) Valve** (2)	**Compressor** (1)	**Fan Motor** (3)	**Duration**
Initial Start-up / Start-up after Automatic Shut-off	ON	ON	ON	OFF	OFF	175 Seconds
Refrigeration System Start-up	ON	ON	ON	ON	ON	5 Seconds
Freeze Cycle	ON	OFF	OFF	ON	ON	* Automatically Determined at Beginning of Freeze Cycle
Harvest Cycle	OFF	ON	ON	ON	ON or OFF	** Automatically Determined During Last Minute of Freeze Cycle
Automatic Shut-off	OFF	OFF	OFF	OFF	OFF	Until Bin Thermostat Re-closes

* Maximum freeze cycle allowed by electronic control is one-hundred and twenty (120) minutes.
** Minimum harvest cycle allowed by electronic control is sixty (60) seconds.

Initial Start-up / Start-up after Automatic Shut-off

For 175 seconds (2.9 minutes) the water pump, water inlet valve, and hot-gas (harvest) valve are energized (See Figure 3-5). This is done for the following reasons:

1. The water pump will start to spray water indicating the ice machine is on and this also helps to clear the evaporator/cubes.
2. The water inlet valve opens, filling and overflowing the water trough.
3. The harvest valve opens, helping to equalize the refrigeration system before ice production begin.

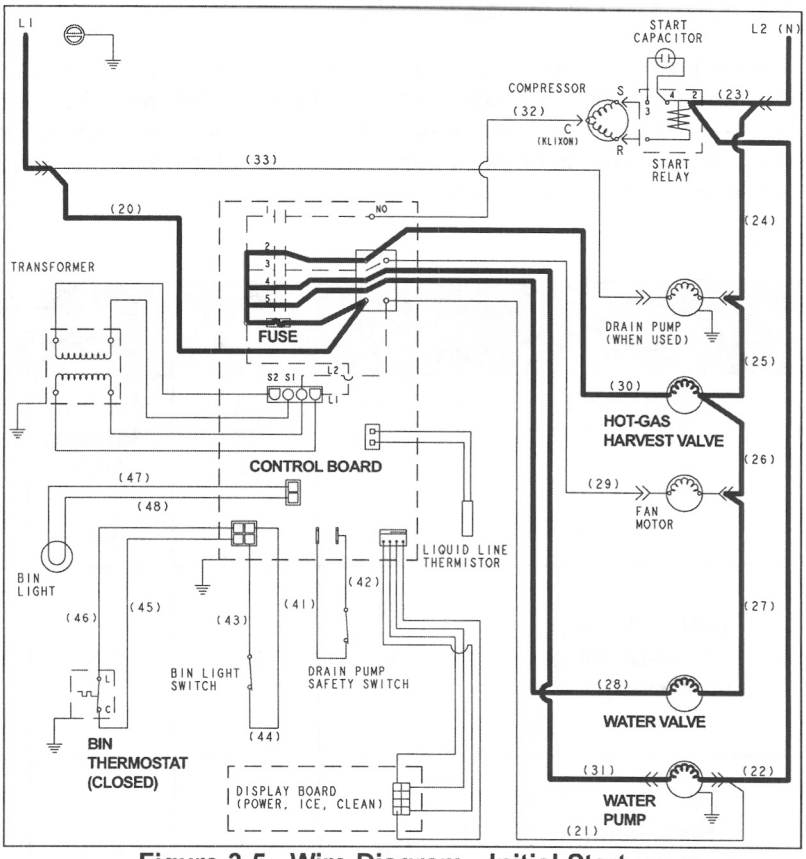

Figure 3-5. Wire Diagram - Initial Start-up

Refrigeration System Start-up

For 5 seconds the compressor, condenser fan motor, water pump, water inlet valve, and hot-gas (harvest) valve are energized (See Figure 3-6). The main reason for leaving the harvest valve open at this time is to start and run the compressor for 5 seconds unloaded. This lengthens the life of the compressor.

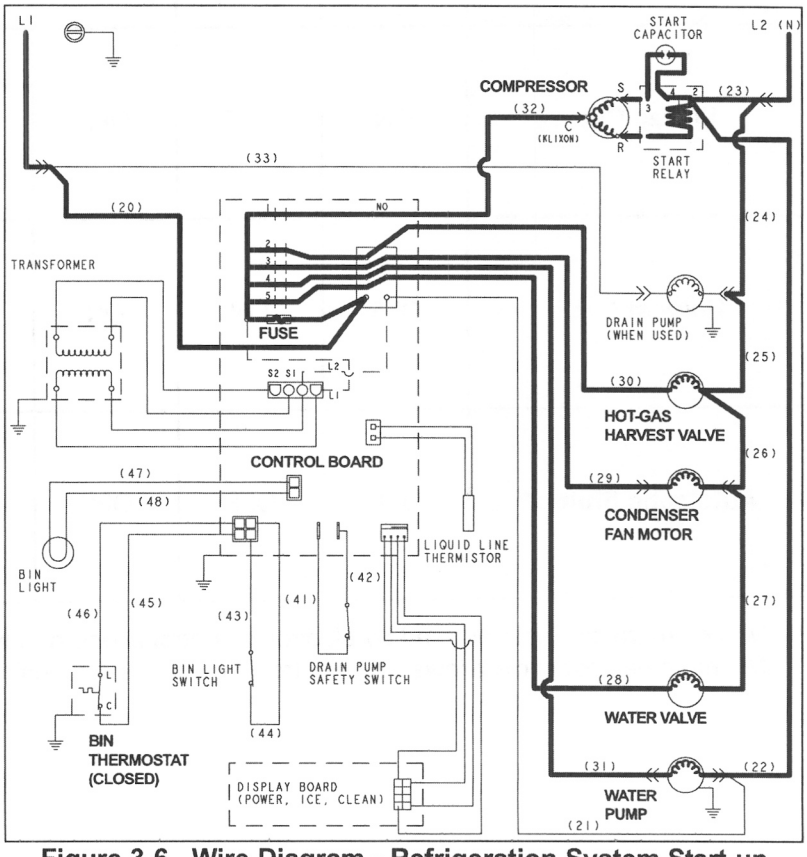

Figure 3-6. Wire Diagram - Refrigeration System Start-up

Freeze (Ice Making) Cycle

During the freeze cycle, only the compressor, condenser fan motor and water pump are energized (See Figure 3-7). The compressor pushes refrigerant through the sealed system, the condenser fan draws air through the condenser, and the circulating pump pushed water through the spray nozzles to the cube molds (See Figure 3-8). The refrigerant running through the evaporator absorbs heat from the water being sprayed into the cube molds and the water freezes. The heat that the refrigerant absorbs from the water is carried in the refrigerant back to the compressor and then through the condenser where the heat is transferred from the refrigerant to the air being drown through the condenser by the condenser fan. This warm air discharges out through the left side of the kickplate.

As the freeze cycle runs, the electronic control monitors the temperature detected by the thermistor attached to the liquid line/condenser outlet (See Figure 3-7) and calculates freeze time based on the the amount of sub-cooling detected.

NOTE: *Maximum freeze cycle is 120 minutes.*

NOTE: The Water System During Freeze Cycle - *The reservoir is initially filled with approximately two quarts of water, either following a harvest cycle or after an initial start-up. During the ice making cycle, water is taken from the reservoir and sprayed up into the molds where it freezes. However, water containing mineral impurities requires lower temperatures to freeze, so the less pure water falls back into the reservoir while the purer water freezes in the cube molds. This causes the water in the reservoir to become highly concentrated with mineral impurities at the end of the freeze cycle.*

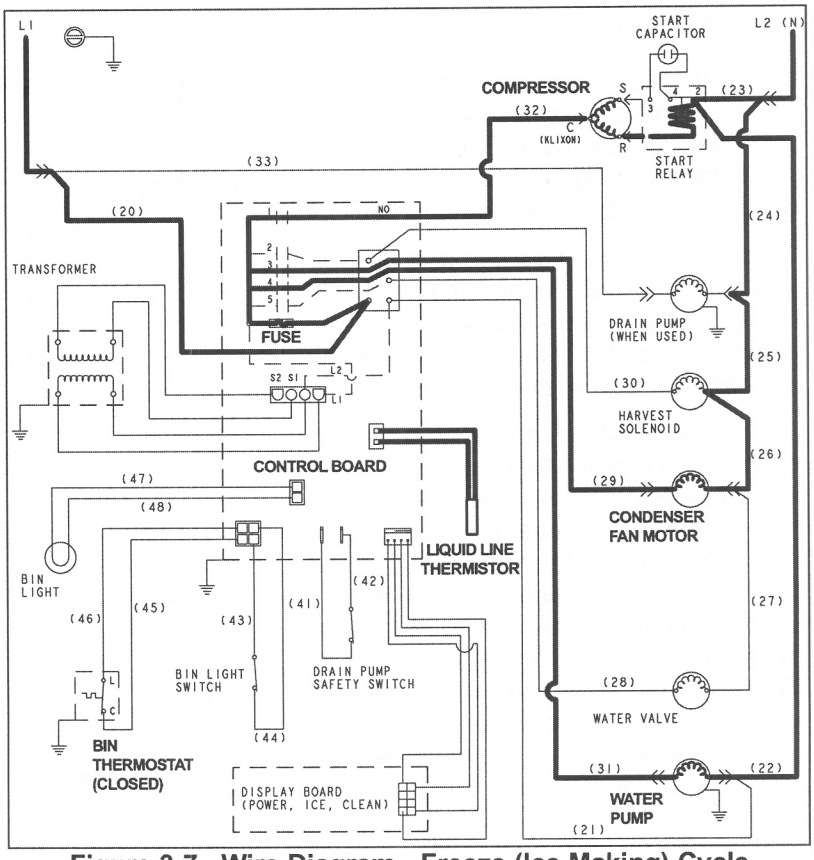

Figure 3-7. Wire Diagram - Freeze (Ice Making) Cycle

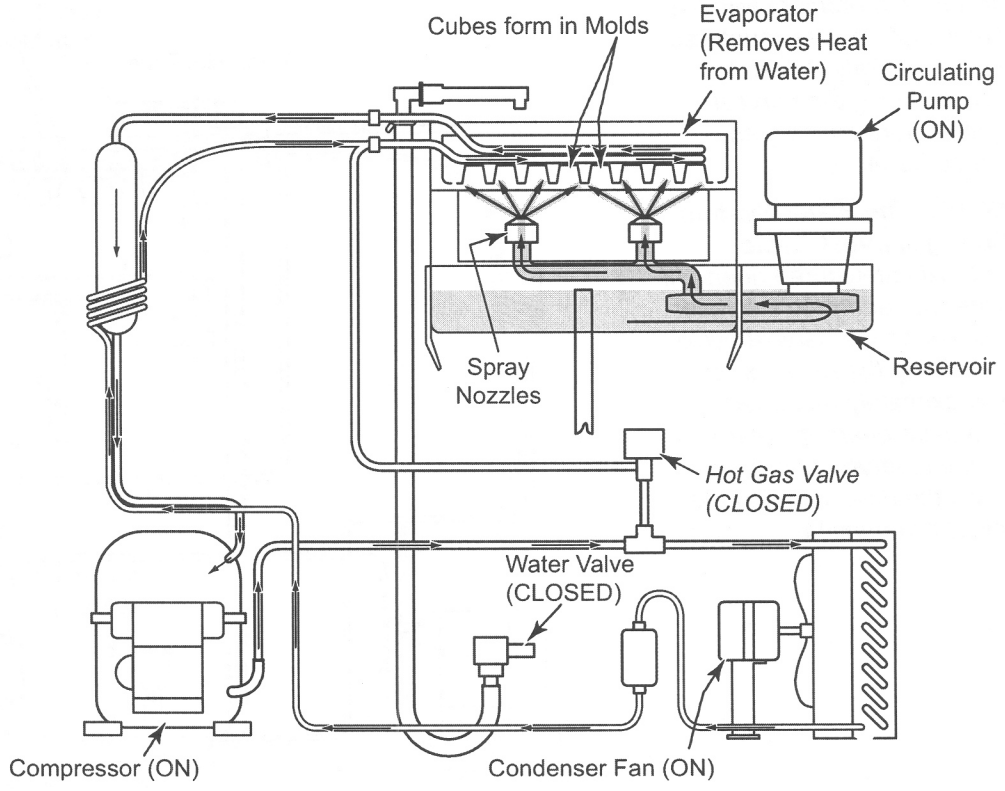

Figure 3-8. Refrigeration and Water System Diagram - Freeze (Ice Making) Cycle

Harvest Cycle

During the last minute of the freeze cycle the electronic control observes the temperature detected by the the thermistor on the liquid line (See Figure 3-9), then calculates and controls proper harvest duration.

Once in a harvest cycle, the compressor and condenser fan motor remain energized, with the hot gas valve and water valve also being energized, but the water pump is switched off (See Figure 3-9).

During the harvest cycle the compressor continues pushing refrigerant through the sealed system, but with the hot gas valve open, the high-pressure/high-heat gas from the compressor is diverted to the evaporator instead of the condenser. The water valve is opened to pour water over the top of the evaporator and into the reservoir. With the water pouring over the top of the evaporator and the warm gas running through the evaporator, the ice cubes release from the cube molds and fall into the storage bin.

NOTE: *Minimum harvest cycle is 60 seconds.*

NOTE: *If a problem with the water system is encountered, it is more likely to lead to issues during the harvest cycle before causing any freeze issues.*

NOTE: The Water System During Harvest Cycle - *Approximately three quarts of water are added to the reservoir during the harvest cycle, over-filling the reservoir by approximately one quart. The extra quart of water rinses the reservoir and goes down the drain carrying the mineral impurities.*

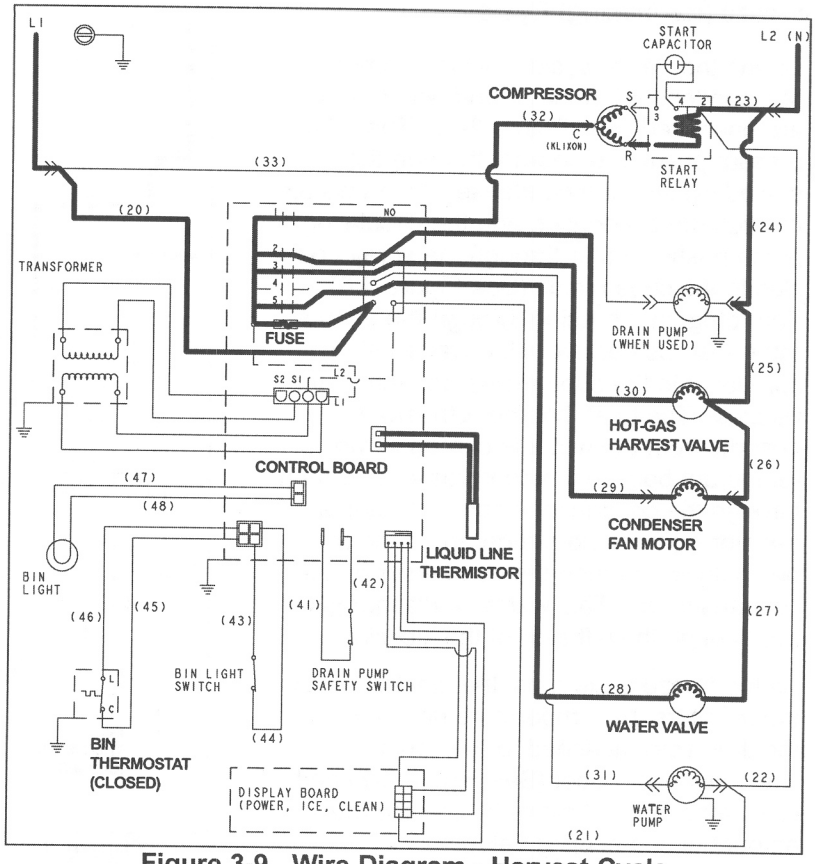

Figure 3-9. Wire Diagram - Harvest Cycle

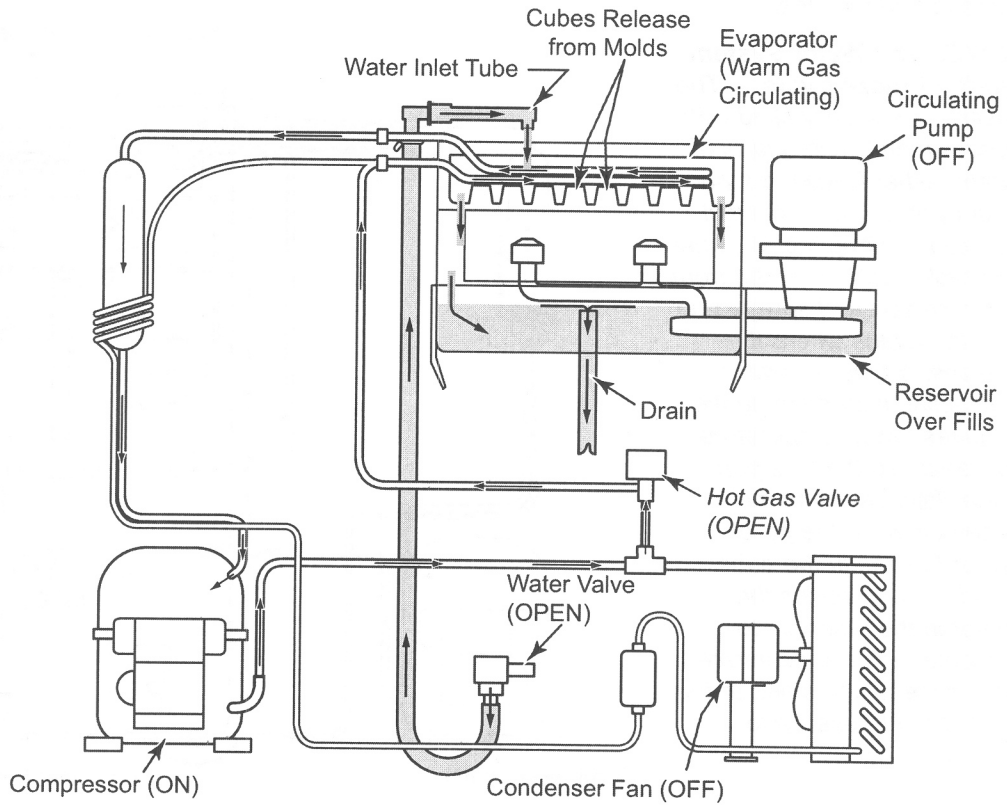

Figure 3-10. Refrigeration and Water System Diagram - Harvest Cycle

Automatic Shut-off

If/when the ice in the bin reaches the bin level thermostat, the thermostat will open, interrupting ice production until enough ice is removed/used or after enough ice melts (See Figure 3-11).

NOTE: *The bin level thermostat cut-in is 40°F (4.5°C) and cut-out is 34°F (1.0°C).*

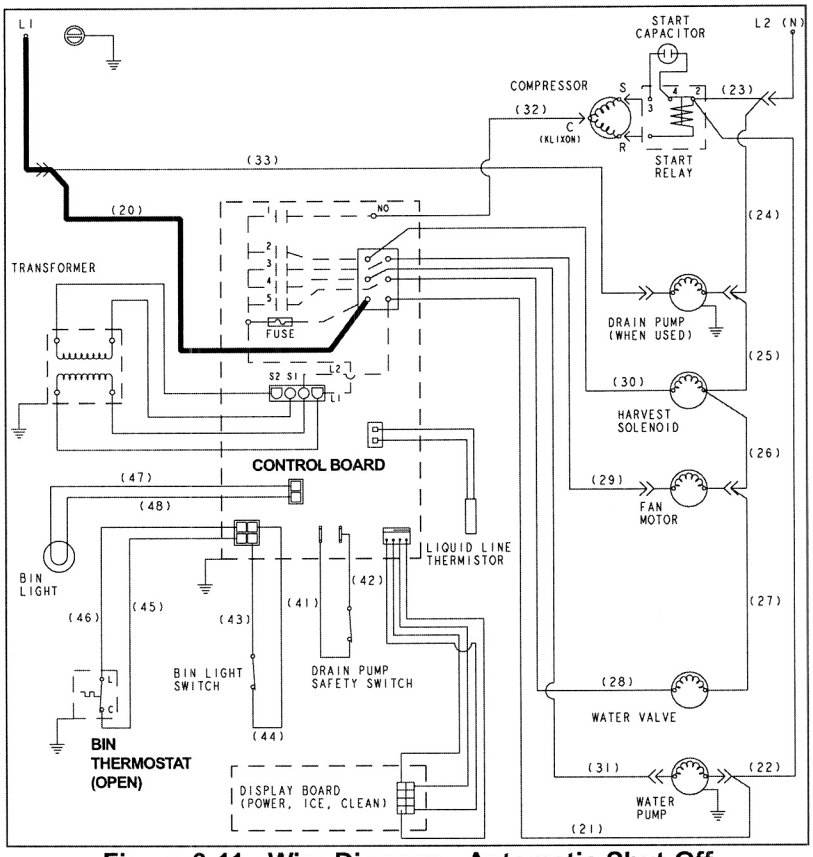

Figure 3-11. Wire Diagram - Automatic Shut-Off

WHAT TO EXPECT FROM THE MODEL UC-15I

The model UC-15I will release a batch of cubes approximately every thirty minutes. At the same time the cubes fall into the bin, water will be filling the reservoir and carrying the mineral impurities down the drain.

Ice

The general shape of the ice cubes is octagonal and tapered toward the top, with the base being approximately 1-1/4" wide, the top being approximately 1" wide and the height being approximately 1-1/8" (See Figure 3-12). When the machine is adjusted properly, there should be approximately 1/4" deep dimple in the base of the cube. (See Cube Weight Adjustment later in this section) The cubes will be wet when fresh, which is normal. The cubes may also develop frost on the outside and look cloudy, this is also normal. (The frost will disappear when liquid is poured over the cubes.)

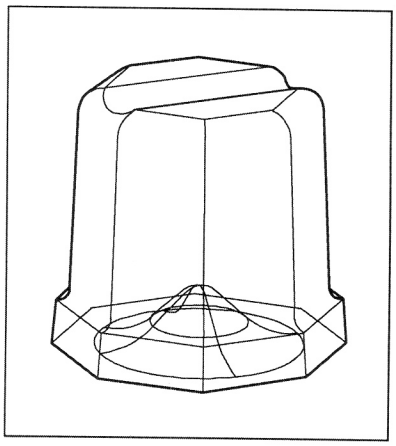

Figure 3-12. Proper Cube Appearance

Storage

The ice storage bin is not refrigerated, but it is insulated, similar to a picnic cooler. If the ice bin were refrigerated, the cubes would freeze together into one large cluster of ice. This would yield ice that is of very poor quality and would be very difficult to remove from the machine.

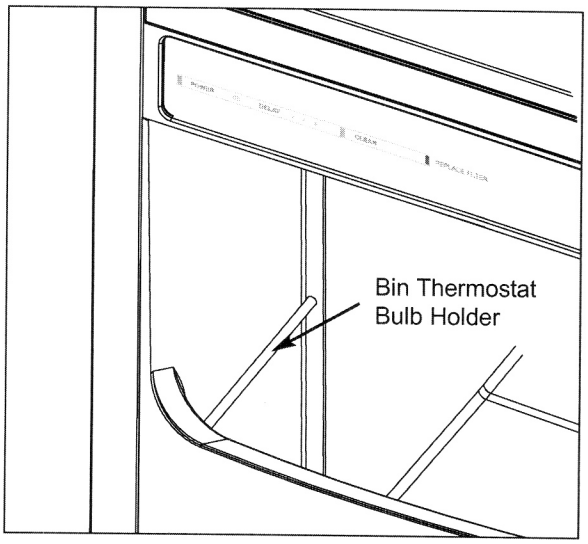

Figure 3-13. Ice Bin Storage Level

Run Time

The model UC-15I will continue to operate until the ice builds up high enough to contact the bin thermostat sensor tube, then it will switch OFF(See Figure 3-13). The ice machine remains OFF until ice no longer contacts the bin thermostat bulb holder and the thermostat bulb warms up. The increase in temperature will restart the ice machine.

The amount of time that the model UC-15I will run to replace melted ice (without the door being opened) is approximately four (4) hours per day.

The amount of time that the ice machine will run to replace ice removed during use will depend upon how much ice is removed, how often ice is removed, how clean the ice machine is and how hot the ambient air and water supplied to the ice machine are. An empty ice bin will usually take twelve (12) to twenty-four (24) hours to refill.

NOTE: *The models UC-15IP and UC-15IPO have a drain pump that is powered off of L1, so even when the ice machine is switched OFF, the pump can continue to pump melted ice water to the drain.*

Testing and Adjusting the Bin Thermostat

The bin thermostat stops the ice machine when the bin is full. It is preset for normal ambient temperatures and adjustments are usually not required.

Testing the Bin Thermostat - The thermostat is functioning correctly if, when three ice cubes are placed on the thermostat tube for 5 minutes, the ice machine stops. The ice machine should restart 5 minutes after the cubes are removed.

Adjusting the Bin Thermostat - If the ice machine stops before the bin is full or runs after the bin is full, ambient temperatures are probably high or low and the bin thermostat can be adjusted as follows (See Figure 3-14):

⚠ WARNING

POWER IS SUPPLIED TO ICE MACHINE DURING THIS PROCEDURE. AVOID CONTACT WITH THE FAN BLADE AND THE ELECTRICAL CONNECTIONS.

1. Extract four bolts holding kickplate and pull it forward.
2. Turn thermostat adjustment screw counterclockwise to decrease the level of ice; turn clockwise to increase the level of ice.
3. Reassemble the kickplate.

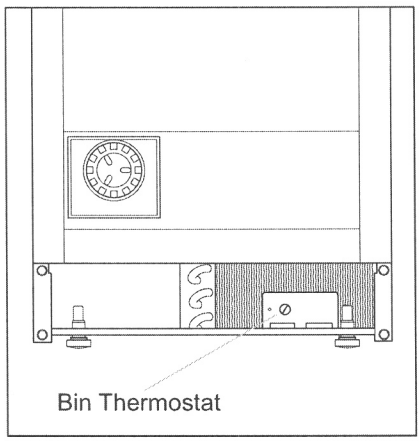

Figure 3-14. Bin Thermostat Adjustment

Cube Weight Adjustment

The ice machine has been programmed to produce the proper cube weight, based on average ambient air and water temperatures. Cube weight can be increased from the factory setting, reducing the amount of dimple in the cube, by adjusting the freeze cycle finish time in one (1) minute increments.

Adjusting Freeze Cycle Finishing Time - To adjust freeze cycle finish time press and hold the POWER button. While holding the POWER button, press and release the CLEAN button once for each additional minute of freeze cycle time desired. (See Figure 3-15)

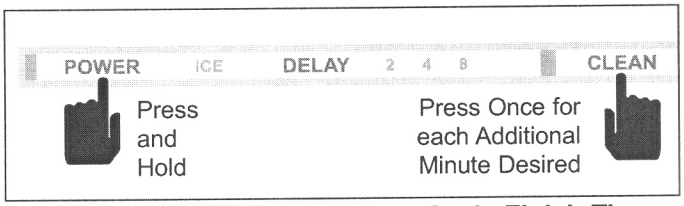

Figure 3-15. Adjusting Freeze Cycle Finish Time

It is recommended to adjust in one (1) minute increments and allow the ice machine to run several freeze/harvest cycles, then inspect the ice cubes. If a heavier cube weight is desired add another minute of freeze time and repeat the process.

NOTE: *Five (5) minutes is the maximum additional freeze time that can be added. Pressing the CLEAN button 6 times will reset the finishing time to zero (0) additional minutes.*

Checking the Additional Freeze Cycle Time - To check the number of minutes that have been added to the freeze cycle time (See Figure 3-16):

1. Press and hold the POWER button for five (5) seconds.
2. Count number of times the ICE light flashes. Each flash indicates an additional minute of freeze cycle time.

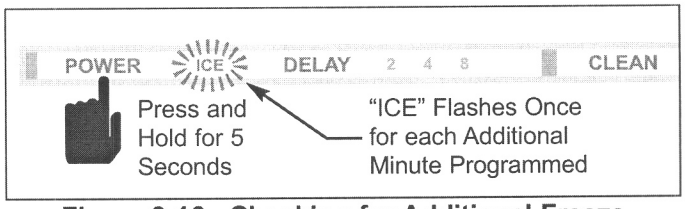

Figure 3-16. Checking for Additional Freeze Cycle Finish Time