SECTION 3

BASIC AUTOMATIC CONTROLS

UNIT 14

Automatic Control Components and Applications

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Discuss space temperature control.
- Describe the mercury control bulb.
- Describe system overshoot and temperature swing.
- Describe the difference between low- and high-voltage controls.
- Name components of low- and high-voltage controls.
- Name two ways motors are protected from high temperature.

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Describe the difference between a diaphragm and a bellows control.
- State the uses of pressure-sensitive controls.
- Describe a high-pressure control.
- Describe a low-pressure control.
- Discuss the range and differential of a control.

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Describe pressure transducers.
- Describe a pressure relief valve.
- Describe the functions of mechanical and electromechanical controls.

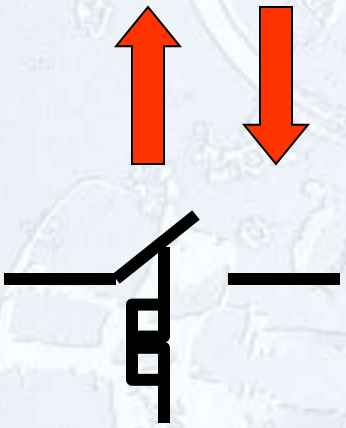
TEMPERATURE CONTROLS

- Cooling thermostats close on a rise in temperature
- Heating thermostats close on a temperature drop
- Can be used to protect motors from overheating
- Low voltage controls can protect high voltage devices
- Low voltage controls are smaller and switch electrical contacts faster then high voltage controls
- Residential systems often have low voltage controls

THE HEATING THERMOSTAT

CLOSES ON A DROP IN TEMPERATURE

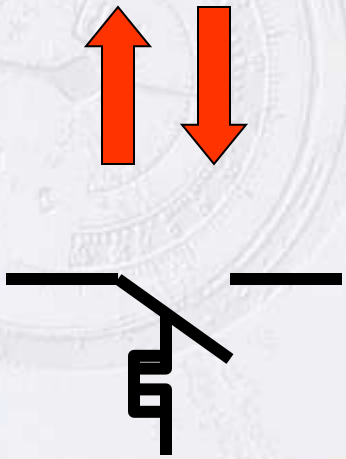
OPENS ON A RISE IN TEMPERATURE



THE COOLING THERMOSTAT

CLOSES ON A RISE IN TEMPERATURE

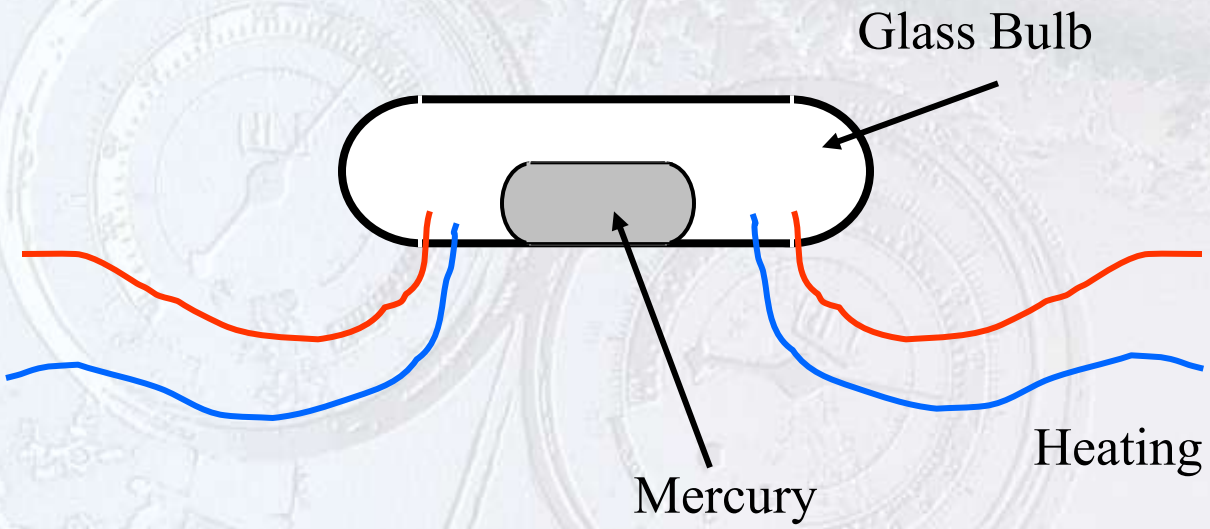
OPENS ON A DROP IN TEMPERATURE



SPACE TEMPERATURE CONTROLS, LOW VOLTAGE

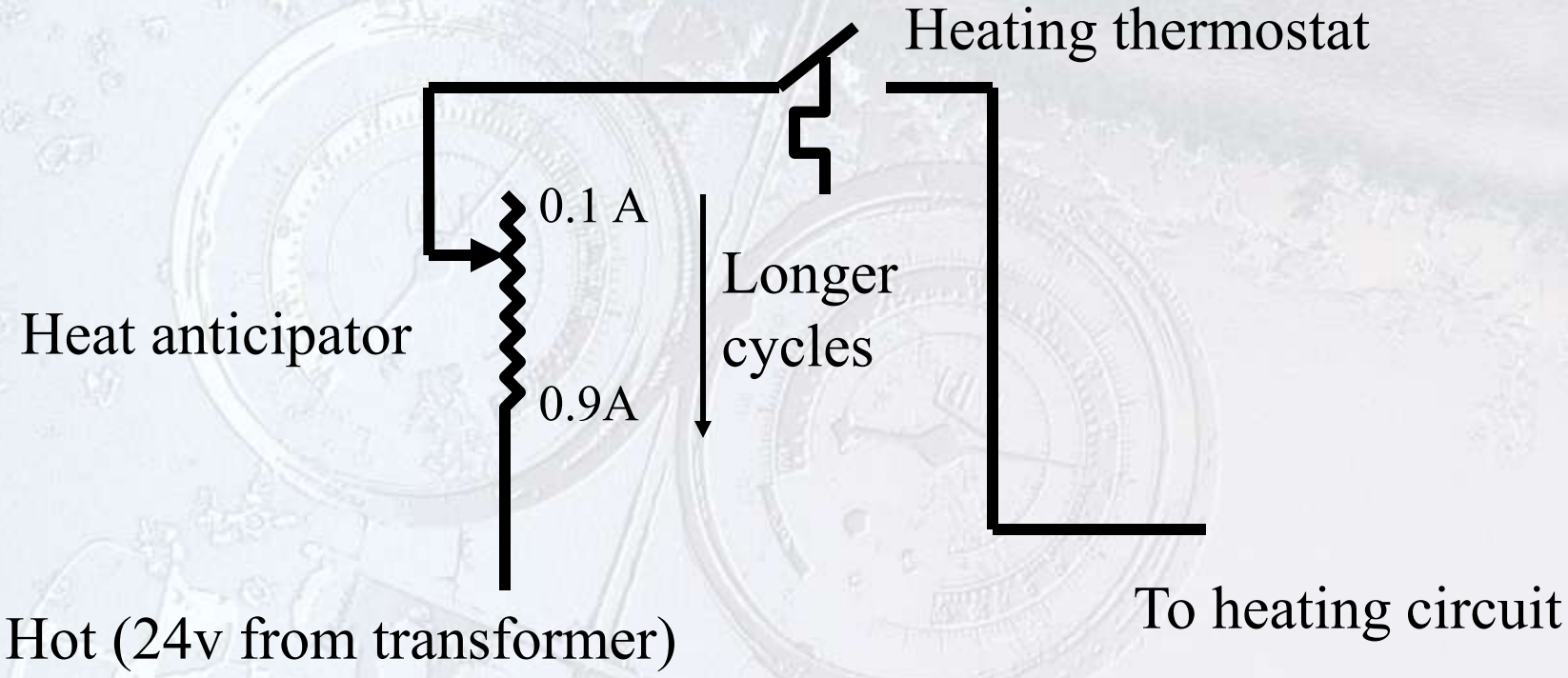
- Carry only small amounts of electric current
- Can use mercury or silver coated contacts
- Heat anticipator -used to reduce system overshoot
- Cold anticipator – anticipates system lag
- Temperature swing = System overshoot – Lag
- Thermostat subbase – provides mounting base for thermostat and means to make electrical connections

In the cooling mode, the cooling contacts are closed and the heating contacts are open

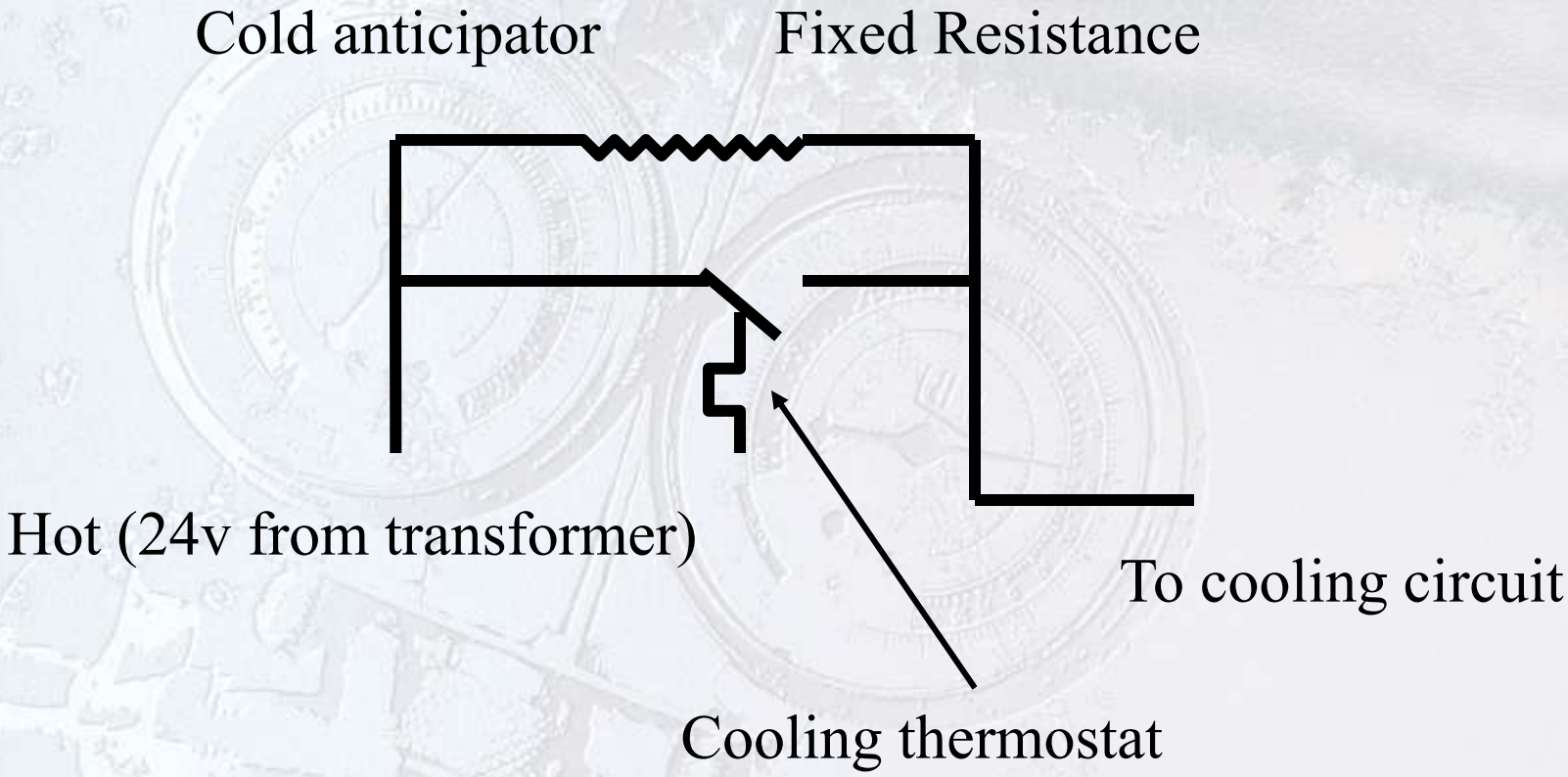


In the heating mode, the heating contacts are closed and the cooling contacts are open

THE HEAT ANTICIPATOR



THE COLD ANTICIPATOR

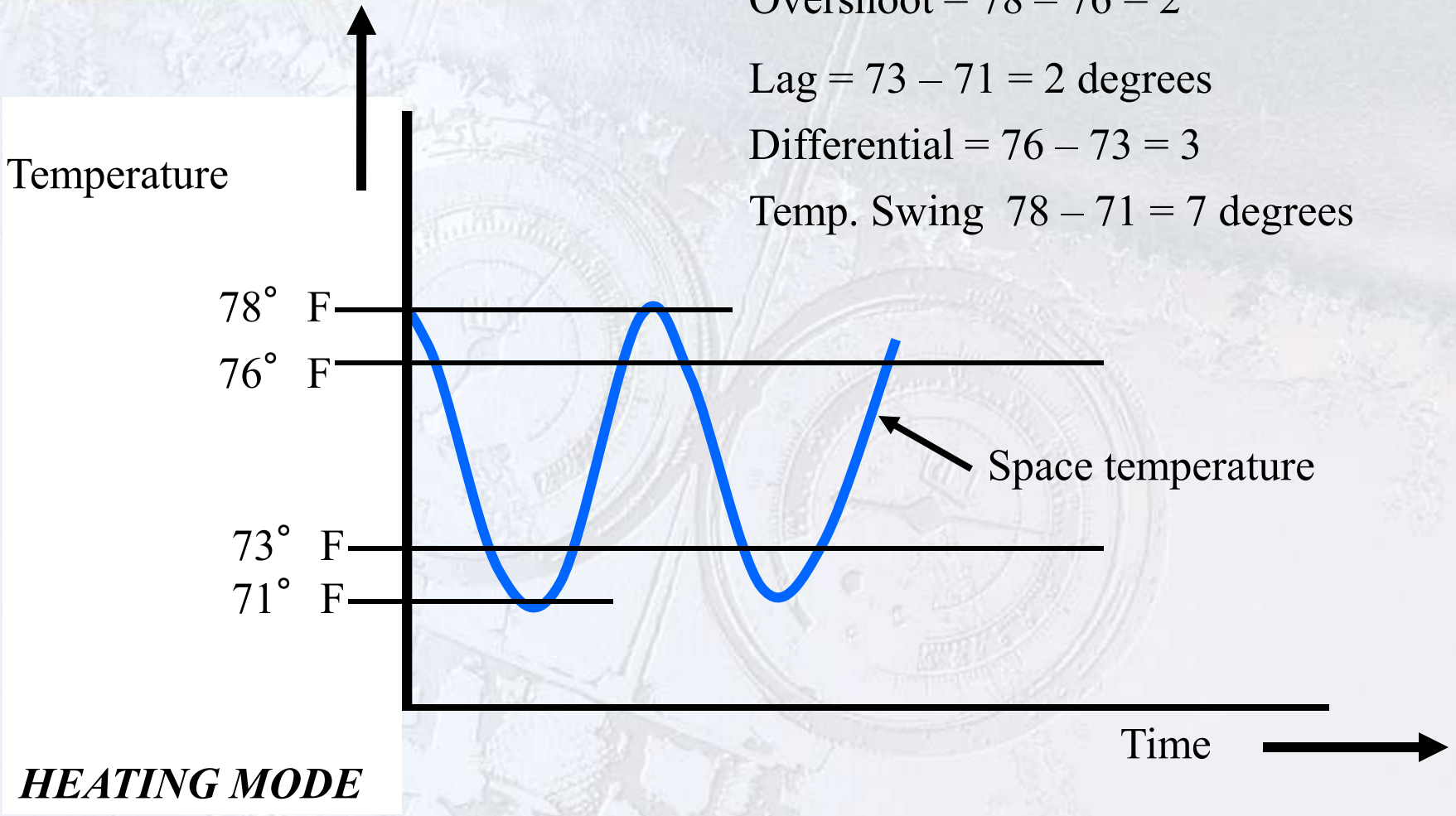


Overshoot = 78 – 76 = 2

Lag = 73 – 71 = 2 degrees

Differential = 76 – 73 = 3

Temp. Swing 78 – 71 = 7 degrees



HEATING MODE

SPACE TEMPERATURE CONTROLS, HIGH (LINE) VOLTAGE

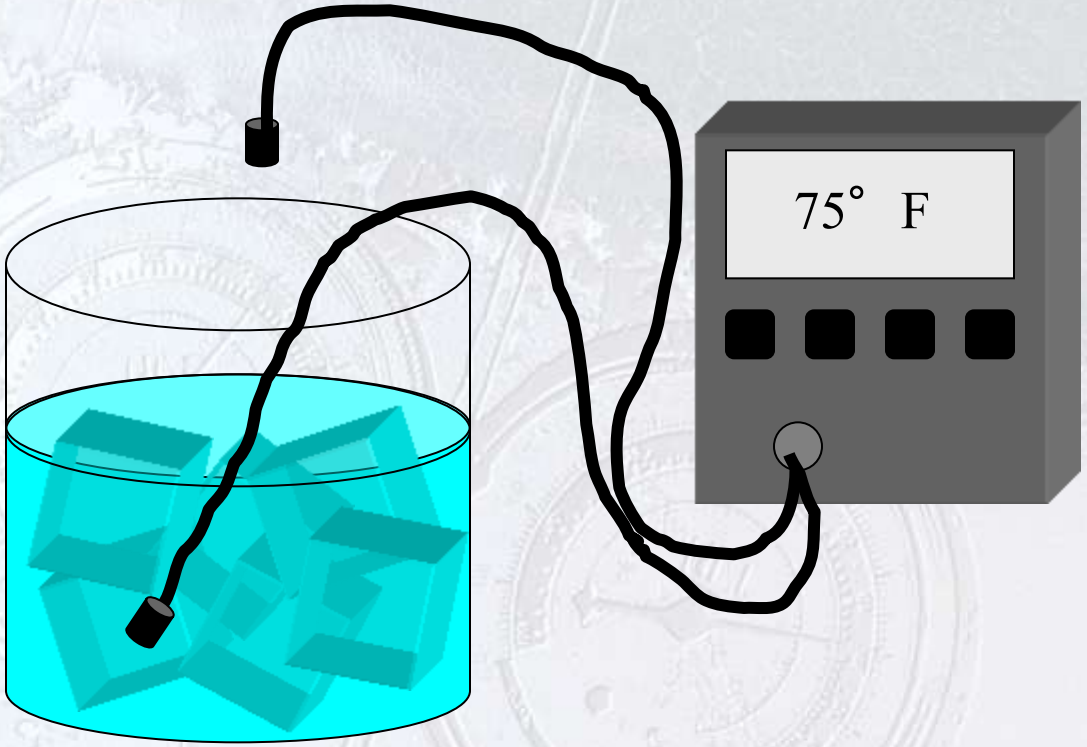
- Commonly found on self-contained equipment such as window air conditioners or refrigerators
- Heavy duty devices
- Not as sensitive as low-voltage controls
- Use bimetal, bellows or liquid-filled remote bulbs
- Often use mercury bulb or silver coated contacts
- Secured cover to prevent tampering

SENSING THE TEMPERATURE OF SOLIDS

- Sensing element is insulated for accuracy
- Sensing bulb should be secured to the solid
- Motor protection is accomplished with a thermistor or bimetal strip
- Thermistors are often embedded in the motor windings

SENSING THE TEMPERATURE OF FLUIDS

- Fluids include liquids and vapors
- Temperature measurement is often made by immersion
- Bulb can be insulated for accurate measurements
- On larger systems and piping arrangements, thermometers can be mounted in wells
- To measure air temperature, the thermometer probe can be placed directly in the air stream



The probe of the thermometer should be submerged in the liquid if possible

PRESSURE-SENSING DEVICES

- Measure and/or control the pressure of refrigerants, air, gas, water and other fluids
- Often used to control electrical switching devices
- Can either open or close on a rise in pressure
- Can be used to sense a pressure differential
- Can be used as operational or safety devices
- Differential = Cut in pressure – Cut out pressure
- Some controls are adjustable, while others are not

ELECTRONIC PRESSURE CONTROLS

- Contain small microprocessors and use pressure transducers
- Transducers convert the sensed pressure to an electronic signal
- Signal is processed by the microprocessor
- The processor then adjusts system operation according to the pressure-generated signals
- System changes may involve compressor or condenser fan motor cycling

HIGH PRESSURE CONTROLS

- Normally closed device that opens on a rise in pressure
- Device is connected to the high pressure side of the system
- Used to disable a compressor if the head pressure exceeds safe limits
- Can be an automatic or manual reset device
- Can be factory set or field adjusted

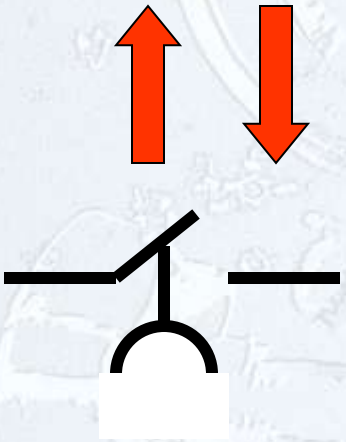
LOW PRESSURE CONTROLS

- Normally closed device that opens on a drop in pressure
- Connected to the low pressure side of the system
- Can be used for temperature control or for low charge protection
- Usually an automatic reset device
- Can be automatic or manual reset devices

The High Pressure Switch

Closes on a drop in pressure

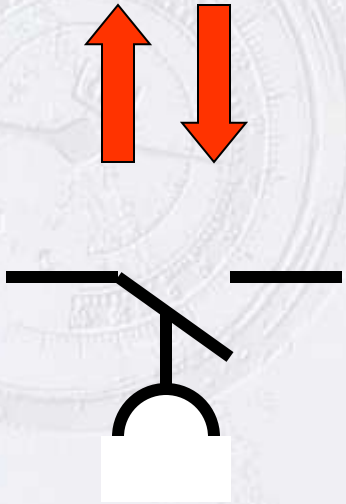
Opens on a rise in pressure



The Low Pressure Switch

Closes on a rise in pressure

Opens on a drop in pressure



OIL PRESSURE SAFETY CONTROLS

- Operates on a differential in pressure
- Net Oil Pressure = Oil pump pressure – Suction pressure
- Ensure that compressors operate with sufficient oil pressure
- Most compressors need at least 30 psig to operate correctly
- The control has a built in time delay
- The cutout time delay is normally about 90 seconds
- Can be a mechanical or electronic device
- Electronic controls use pressure transducers

AIR PRESSURE CONTROLS

- Can verify airflow through duct systems
- Can be used to determine pressure differentials
- Can be used as an interlock between the system blower and electric heaters
- Can be used to initiate the defrost cycle on heat pump systems

WATER PRESSURE REGULATORS

- Controls water pressure to main system components
- Often used on hydronic heating systems and systems using water-cooled condensers
- On hydronic systems, the valve opens on a drop in pressure to add water to the water circuit
- On water-cooled systems, the valve opens on a rise in head pressure to increase water flow through the condenser

GAS PRESSURE SWITCHES AND REGULATORS

- Gas switches are often used as safety switches
- Gas switches are normally closed devices and will remain closed unless an unsafe condition exists
- Gas switches should never be jumped out
- Gas regulators reduce gas supply pressure to the working burner pressure
- Gas regulators can be adjusted

MECHANICAL AND ELECTROMECHANICAL CONTROLS

- Mechanical controls operate independently from other controls
- A water-regulating valve is a mechanical control
- Electromechanical controls convert mechanical movement into some electrical activity
- A sail switch is an example of an electromechanical control

MECHANICAL CONTROL MAINTENANCE

- Water regulating valves should be checked for leaks
- Corrosion, wet spots and rust indicate leaks
- Pressure relief valves can be tested by lifting the lever
- Check to make sure that the valve seats properly
- Be careful since the water can be very hot

ELECTROMECHANICAL CONTROL MAINTENANCE

- Check for water leaks, if applicable
- Check transmission lines for leaks
- Ensure that controls are mounted securely
- Check for frayed or burned wires
- Check for excessive control vibration

UNIT SUMMARY

- Space temperature is controlled by thermostats
- Thermostats can also be used to protect electrical components
- Heating thermostats close on a drop in temperature
- Cooling thermostats close on a rise in temperature
- Temperature swing = System Overshoot – System Lag
- Pressure controls open and close in response to sensed pressures
- Differential = Cut in pressure – Cut out pressure
- Mechanical controls operate independently of other controls
- Electromechanical controls result in some electrical activity