



## Introduction & Purpose of this How-To Guide

At Portage Electric Products, Inc. (Pepi®), we have been making bimetallic thermal control devices to make and break electrical circuits for almost a half century. Although the technology behind bimetallic thermal controls has remained essentially the same during this time, the manufacturing technology we use to make these devices has taken quantum leaps forward.

One other constant that has not changed and never will, is the inherent characteristics of bimetallic thermal controls that makes them exceptionally versatile, functional, and reliable in a wide variety of applications. In many applications they are the perfect solution, and in other applications there are better choices.

Our purpose in this *How-To Guide to Thermal Controls* is twofold: (1) We want to help you understand the type of applications where bimetallic devices work best. (2) If you are involved in one of these applications, we want to help you do it better.

## Defining Thermostats & Thermal Protectors

A question which can confuse the most seasoned engineering veteran involved with new product development. The terminology that is used for most thermal control devices is dependent on how it has been tested by one or more worldwide safety approval agencies.

The key question is what you need your thermal devices to do. In very simple terms, if a thermal control will continually make and break the circuit to maintain temperature control, or if they will need to cycle frequently, you will need a bimetallic **Thermostat**.

If your application requires a thermal control device to simply provide over-current or over-temperature protection, then you will need a **Thermal Protector**.

The basic mechanical difference between thermostats and thermal protectors is found in the internal and external dimensions of the device. Based on the criteria established by most safety approvals agencies, a thermostat requires additional spacing requirements so that there is more "through air" or "over surface" spacing to serve as additional electrical isolation. In general a **Thermostat** will be slightly larger than a **Thermal Protector** due to the additional spacing requirements.

## Types of Thermal Control Devices

There are many different basic types of what is generally classified as *thermal control devices*. Each type is designed to react to changes in temperature or current to make or break an electrical circuit. In fact, each



of these basic types can be expanded into various sub-categories that are used in so many different applications, they are too numerous to mention.

The basic types of thermal controls include:

- **Cantilever Bimetallic Devices (Automatic Reset, Self-Hold, & Non-Reset Types)**
- **Disc-Type Bimetallic Devices (Automatic Reset, Self-Hold, & Manual Reset Type)**
- **Adjustable Temperature Type Devices**
- **Solid State Type Devices**
- **Electronic Type Control Devices**
- **Thermal Fuses**

Each of these control devices does some things better than others. There are no hard and fast rules and many application factors need to be considered. In many applications multiple thermal controls are used to offer the highest degree of product safety to the consumer. There are some general considerations that determine when certain types of devices are probably your best bet.

*Cantilever* bimetallic devices, which is the technical term applied to most single element bimetallic type controls, excel at handling electrical loads up to six amps and can operate on currents from millivolts up to 240 VAC. The construction techniques vary widely for these types of thermal controls and the operating characteristics for each type can vary based on the style of construction. There are two basic types of Cantilever controls that include *Creep Action* and *Snap Action* type bimetallic controls.

Basically *creep action devices* get their name from the movement of the bimetallic element used in this construction type. A *creep action device* utilizes a single bimetal element which either will open or close an electrical circuit based on increases in temperature and or current. The bimetallic element is produced so that there is little or no temperature differential between the opening and closing point of the devices. In certain applications, this produces a narrow temperature operating range which is desirable in many application types.

*Snap action devices* are similar in function to creep action devices in that snap action devices will open and close an electrical circuit based on increases in either temperature and or current. The real difference is that they are produced with specially formed bimetallic elements which produce a wider temperature variation between the point where the thermal control opens and the point at which the device will close. The devices get their name from the “snapping” sound that the bimetallic element makes when it reacts to changes in temperature.

*Disc-type bimetallic devices* get their name from the shape of the bimetallic element that is utilized in these devices. The bimetallic element is generally round in shape and is then specially formed to give it a “disc” like shape. The size of the bimetal discs does vary depending on the construction styles of various manufacturers but disc-type devices generally come in ½” and ¾” disc styles. Since the bimetallic disc is



usually electrically isolated from the electrical circuit, these devices are generally more suitable for applications where you need to interrupt resistive current loads of more than six amps.

*Adjustable devices* are used when there is a need to allow for temperature adjustment in the end application. The size and shape of these devices vary widely based largely on the temperature range that the devices will control and also based on the actual application. These devices include what are commonly referred to as capillary type controls, bulb & capillary type controls, "stack" type or leaf thermostats, and adjustable electronic type controls.

*Solid state and Electronic type control devices* cover a variety of applications. The products used for these applications can range from individual temperature sensors comprised of various materials all the way to entire circuit boards. In some cases, solid state devices can not only generate heat, but regulate it as well. In general, solid state and or electronic type devices are associated with very precise temperature measurement and control.

*Thermal fuses* are generally the most cost effective solution for limiting an over-temperature condition in customer applications but are the least versatile type of device as they contain a fuseable link which operates one time and then must be replaced. These devices are commonly referred to as "One-shots" or one time use type control. These devices are good to use either as a back-up device to a resettable type device or when a catastrophic occurrence is possible and you would want the product to totally shut-down.

## **Functionality of Thermal Control Devices**

In order to determine how to select the best thermal control device for your application, it is good to know what operating characteristics you desire for a thermal control to exhibit in an application. Just like there a variety of thermal control devices which are available, there are also a variety of ways in how they can be used.

The main uses for thermal control devices are:

- **Temperature Control**
- **Over Temperature Protector**
- **Temperature Sensor**
- **Manual Reset Device**
- **Non-Reset Device**
- **Self-Hold Device**

### ***Temperature Control***

Temperature Control functionality is when a thermal control is utilized in an application to control or regulate the temperature of a "heated" application. The primary function of the thermal control is to maintain a



defined operating temperature which a design engineer has determined to provide for optimum performance of the end application. In these applications, the thermal control device will open and close at a preset temperature which will regulate the operating temperature of some type of heater.

This is the most difficult application type for thermal controls since the controls are required upon to carry the full electrical load of the application. However, the devices that provide functionality in these applications are designed, constructed, and tested to provide optimum performance under these conditions.

### ***Over Temperature Protector***

Over Temperature Protector type controls function like their name implies. The primary function of these devices is to provide high limit temperature protection in applications where the normal operating temperatures have increased due to over work or another type of fault condition. Generally, these devices will carry the full electrical load of the application. Depending on the type of fault condition that exists, many thermal controls utilized as over temperature protectors will function either by the thermal control “seeing” an increase in temperature in the application, or by “sensing” an increase in the electrical load in the application, or through a combination of these two conditions.

### ***Temperature Sensor***

Temperature Sensor type controls function again like their name implies. The primary function of these devices is to open or close an electrical circuit that may or may not be the primary electrical circuit of the application. This means that these devices may or may not carry the full electrical load of the application. In general, the function of a temperature sensor is to monitor the temperature of one or more components of an application and either provide a signal function to another device in the circuit or control the function of another device in the circuit. This would include applications like turning on a ready light in an application or activating a cooling fan for other electronic components.

### ***Manual Reset Device***

Manual Reset devices are thermal controls which are generally used as over temperature protectors in an application. Design engineers may want to incorporate an extra degree of safety in an application by using these types of devices. A manual reset device functions by interrupting the electrical load of an application based on increases in temperature. These devices act in a similar manner to a circuit breaker in that once they are activated, they must be manually reset for the application to function again. In some types of consumer applications, a fault condition can occur due to prolonged or misuse of an electrical appliance. In these instances, the overall temperature in the application has increased to a point where the thermal control device has activated and opened the electrical circuit.



### **Non-Reset Device**

Non-Reset types of bimetallic controls are devices which again are generally used as over temperature protectors in applications. These devices will function much like a manual reset type device in that their primary function is to interrupt the electrical load of an application based on increases in the operating temperature. In some application types, design engineers may want to incorporate an extra degree of safety that goes beyond the functionality of a manual reset device. The difference is that once a non-reset type device functions in an application, the end consumer is not able to reset the control and the application will require servicing by an authorized technician in order for the application to function again.

These devices utilize a specially formed bimetallic element which is designed to operate in a temperature range that is determined by the design engineer. The difference is that due to the special form in the bimetal element, the thermal control will not reset unless it is exposed to temperatures around 5° C or less. These devices offer the functionality of a single operation thermal control but unlike a thermal fuse, they can be 100% tested for function prior to use in the application.

### **Self-Hold Device**

Self-Hold devices are an innovative new type of thermal controls which again are generally used as an over temperature protector in applications. These devices offer functionality similar to manual reset and non-reset types in that they offer an extra degree of safety in many different consumer applications but will automatically reset once the consumer disconnects the power source to the application. Again, the primary function of these devices is to interrupt an electrical load based on increases in the operating temperature or an increase in the electrical load in the application. In a fault condition, the bimetallic element activates at a preset temperature which interrupts the flow of power to the application. Once the thermal control device opens the electrical circuit, a heat source that has been incorporated into the design of the self-hold device is activated preventing the thermal control from resetting as long as the application is connected to a power source. Once the power source is removed (turning off the power switch or pulling the plug from the electrical socket), the heat source is deactivated allowing the thermal control to cool which permits the device to reset.

## **Operating Characteristics & Application Uses**

This section of the How-To Guide offers a closer look at the manner in which each of the basic types of thermal control devices operates and the type of applications where they are best used.

### **Cantilever Bimetallic Thermal controls**

#### *How They Work:*

These devices utilize a bimetallic element to make or break a circuit. The heart of these devices lies in the



bimetallic element. This element is made from specially bonded materials that react differently under the influence of a thermal load. The principle behind how bimetal works makes use of the fact that different metals will expand or contract at different rates when heated or cooled. This is commonly referred to as the coefficient of expansion. The materials which are used to produce bimetal react differently when heat is induced into the bimetal element either through exposure to heat generated by an application or caused by the self-heating effect created by passing current through the bimetallic element, or a combination of both. This permits the bimetallic element to "bend" creating the work force required to make or break an electrical circuit.

The technical name for these controls is to call them a cantilever type in order to differentiate them from disc-type bimetal controls. In cantilever type devices, one or both ends of the bimetallic element are restrained to take maximum advantage of the work force created by the bending effect of the bimetal that is created by increases or decreases in the ambient temperature of an application. In most cases, cantilever type controls are divided into two sub-categories, either *conductive type* controls, or *non-conductive type* controls or also referred to as a shunted type.

In *conductive type* controls, the bimetallic element carries the circuit current so the action of the bimetallic element is not only influenced by responding to any changes in temperature but also by the self heating effect caused by the electrical load passing through the bimetal. This dual action provides for circuit breaker characteristics that can enable the device to function on increases in current as well as in temperature. This self heating of the bimetallic element is commonly referred to as "derating." The derating effect can best be described as the difference between the operating temperature of a control under a no-load condition to that when an electrical load is applied. The derating effect increases with increases in the electrical load.

In non-conductive type controls, the bimetallic element does not carry the circuit current of the application, but provides work force against another internal component that does. The component that carries the electrical load is commonly referred to as a "shunt." Although the bimetallic element does not carry the circuit current, there is some derating caused by the electrical load passing through the shunt element.

### *Versatility*

One advantage of cantilever type controls is that you can customize them to meet the needs of your application. All one has to do, is take advantage of the many different types of bimetal available to easily alter the reactive characteristics. At Portage Electric Products, Inc. (Pepi®) you are offered a choice of the element used in many of our devices making it easier to meet the specific requirements of your application.

Your choice of the bimetal can include choosing a high or low resistance type of element which provides for increased or decreased sensitivity to short circuit conditions in your application. Also, by having a choice as to the type of bimetallic element that best suits the needs of your application, you can tailor the needs of your application which matches the operating specification of the thermal control device. At Pepi® you have a choice in how it works best for your application.



You also have a choice on the function of the bimetallic element as well. Based on the type of bimetallic element used, you can specify a narrow differential between the opening and closing temperature of the device, a wider differential, or a device that essentially does not reset unless the power source is interrupted, or does not reset at all. Engineers also can choose from many different model variations that are designed in a normally closed configuration where the bimetal element will open the electrical circuit upon increases in temperature or designed in a normally open configuration where the bimetal element will close the electrical circuit upon increases in temperature.

Cantilever type controls which provide for a narrow differential between opening and closing temperatures makes them ideal for temperature control applications where it is necessary to continually make or break the circuit. Cantilever type controls which provide for a wider temperature differential permits lower average operating temperatures in applications where the device is used for over-temperature protection. Variations of these types of controls allow for the device to remain in an open state due to the device having a very low reset temperature that would be much lower than the normal ambient temperatures. This type of device permits for 100% testing for function of the device while exhibiting fuse-like operation in the end application. Another variation of this type of control incorporates a heat source either internally or externally to the bimetallic element. This heat source is activated once the bimetallic element opens the circuit current, providing heat to prevent the bimetal from functioning and permitting the device to reclose. The only way the device can be reset, is to disconnect the application from the power source (pull the plug), and the device will reset automatically.

### *Size*

These devices are also generally smaller than other options. With very little room needed to make or break the circuit these cantilever type controls are quite thin, especially when compared to disc-type devices. This small footprint makes it easy for them to fit in tight spaces. Different case configurations and materials also make it possible to fit these flat devices into places other controls simply cannot fit. This includes nestled into the small crevice between AAA cells used in some rechargeable battery packs.

### *Installation*

Cantilever devices are easily wired into circuits and do not require any special mounting hardware unless dictated by the application. Pepi® devices can be ordered with leads attached at the factory making them even easier to install.

### *Safety & Reliability*

Since bimetal devices are resettable they can be tested before and after installation. This not only improves the safety and reliability of the product, but enhances the peace of mind of product designers. This is an especially important feature when comparing these types of devices to thermal fuses which are only effective for a single use and, therefore, cannot be tested. In fact bimetallic devices, with very low reset



temperatures, are sometimes used in the same manner as a thermal fuse. Bimetallic thermal controls produced with a low temperature reset point will open an electrical circuit in a fault condition just like a thermal fuse. However, these devices can be 100% tested for function prior to being installed in the end application. This provides design engineer with an extra layer of protection that is not available with single use devices.

## **Bimetal Disc-Type Thermostats**

### *How They Work:*

As with cantilever type thermal controls, disc type thermal controls rely on a specially formed bimetal “disc” to provide the work force necessary to open and close a set of electrical contacts. The bimetal disc reacts to changes in temperature in an application and will provide the work energy to open and close the contacts. Since the bimetallic element does not carry the circuit current of the application, these devices are not subject to the self-heating effect caused by the electrical load passing through the bimetal element. This gives disc type devices the ability to handle higher current loads.

Like their cantilever counterparts, disc type devices are available with design options that provide for the controls to either open or close an electrical circuit upon increases in temperature. Many manufacturers of disc type thermostats also offer devices with a manual reset feature. This means that once the bimetallic element is activated in the device, the device must be manually reset by the end user in order to restore the flow of electricity to the application. This is the same principle as resetting a circuit breaker. Some manufacturers of disc type devices also offer devices which incorporate self-hold functionality. These devices incorporate the use of an internal heat source which generates enough heat to prevent the device from resetting until external power to the application is removed.

### *Circuit Loads*

The ability of disc-type controls to handle loads is due to the fact they operate strictly on changes in temperature and are designed to be isolated from the circuit current. In disc-type devices, there is no internal heating effect of the bimetal element because of the electrical load passing through the bimetal element. For this reason disc type controls are often more suitable than other controls for resistive current loads above six amps. This includes many common applications in products such as coffee makers and hot water heaters.

### *High Temperatures*

The exterior housings of disc type thermal controls are commonly made of ceramic or some type of plastic material. The type and temperature rating of the plastic materials vary between the different manufacturers of these devices. Some manufacturers utilize higher temperature plastic materials that make them suitable for operating temperature up to 200°C. The housing of these controls can also be made from various types



of ceramic materials making them good choices for very high temperature applications, in some cases well over 300°C.

### *Resetting*

Most manufacturers of disc type controls can also control the reset temperatures of the device. This can provide the end user with the option to specify a wide or narrow temperature differential between the opening temperature and the closing temperature of the controls. A narrow differential between the opening and closing temperature makes disc type devices suitable for use in temperature control applications. If these devices are produced with a wider temperature differential between the opening and closing temperature, then these devices are ideal for use as an over temperature protector in many higher load applications. Some types are available with a "manual" reset function. This means that once the device has functioned due to a fault condition in the application, then the user must manually press a button connected to the device, to reset the electrical contacts. This feature is normally associated with applications where a true fault has occurred in the application and it alerts the end user as to a problem. Again, some disc type devices are available with self-hold functionality that essentially prevents them from resetting unless the power source to the entire application is interrupted.

### *Installation*

Disc type thermal controls are available with a wide variety of mounting options. Many models are designed with a built in mounting brackets which provides ease of installation. Many manufacturers offer a wide variety of mounting brackets that can meet the requirements of your individual application. These mounting options can include fixed flanges, rotating flanges, or threaded screw caps that provides for positive temperature transfer into the devices. Generally disc type devices are equipped with two terminals that are used to connect the devices into the electrical circuit. There is a variety of options available for these terminals as well. These include quick connect style terminals, solder style terminals, screw connect style terminals, or crimp connect style terminals. Also, the position of these terminals can usually be modified to meet the needs of individual applications.

### *Versatility*

Just like their cantilever type cousins, disc type thermal controls can be used in a wide variety of applications. Since bimetal elements are still at the heart of these devices, they are resettable and therefore, can be 100% tested for function by the manufacturer. As with cantilever devices, some disc type controls are available in a normally "open" or a normally "closed" contact configuration.

Just as with our cantilever type controls, at Pepi® design engineers have a wide variety of options available with our ½" disc type controls. You can choose the operating temperature range, the reset method of the device, the reset temperature, the mounting configuration, and more. We realize that the



operating specifications for many applications vary. So you can choose from many options that allows you to specify a thermal control to meet the individual needs of your application.

## **Adjustable Temperature Type Devices**

### *How They Work:*

There are many different types of controls that fall into this category. Normally, these devices enable the end user to manually adjust the temperature of an application such as in an oven or a clothes iron. These devices normally control the temperature in an application, but sometimes also include a secondary set of electrical contacts that are controlled independently provide high temperature limit protection as well. Adjustable temperature type devices are available in three main designs.

### *Capillary and Bulb & Capillary type controls*

These larger and more costly devices are used when remote temperature sensing and control capabilities are required. The switching function of the device is not located at the same place where the temperature sensing is taking place. For these devices to function, the capillary tube of the "bulb," or oil filled reservoir is placed where the temperature sensing is to be preformed. As heat increases or decreases at the capillary end or the bulb end of the tube, high temperature oil expands or contracts and moves through a "capillary tube." This tube is attached to a pressure switch that opens and closes a set of electrical contacts to control the temperature of the application. These devices normally utilize an additional bimetal element to compensate for changes in ambient room temperatures.

### *Stack Type Devices*

This type of adjustable control is used when the control of the temperature is preformed at the same location where the heat is being generated. These devices are normally used in applications requiring higher current loads such as clothes irons and baseboard heaters. These devices consist of multiple "leaf" elements that permit manual temperature adjustment, ambient compensation, and a bimetallic element to provide the work force necessary to open or close a set of electrical contacts to make and break the electrical circuit.

### *Adjustable Electronic Type Devices*

These are probably the most accurate devices available for adjustable temperature applications. However, you normally pay more for this accuracy and the size of these devices is quite large since they require additional electronic circuitry to make them work. Typically, the temperature is measured by one type of electronic circuitry and the actual switching of the load is performed by an electronic relay circuit.



## Solid State Devices

### *How They Work:*

There are many different types of controls that fall into the classification of solid state devices. Basically, these devices are activated by increases in temperature and or current, but have no moving parts. One important aspect to consider is that since there are no moving parts to make or break an electrical circuit, then in some cases, the device is never really achieves a true open circuit status. In many instances, the device becomes "non-conductive" under the effects of changes in temperature and will only remain in an "open" state as long as the device remains under load.

The most common types of solid state devices fall into two categories. These are (1) Polymer devices or (2) Ceramic devices. There are also devices called thermistors types of solid state devices are cheaper than other thermal controls, however they do not have the ability to carry current.

### *Polymer Type Devices*

Polymer type devices are basically conductive strips of a plastic like material. They rely on heat generated from increases in temperature or current to generate thermal energy to provide a self heating effect. This results in a change of the polymer matrix increasing in resistance which then causes the device "trip" the electrical load. This device remains at an elevated temperature so it remains in a "tripped" state or until the power is removed. Normally, these can only be used in lower voltage applications and were not designed for continuous-duty applications. Although there have been improvements in their thermal sensing abilities, these devices are not as thermally sensitive as bimetallic controls. Polymer devices rely on the expansion capability of the polymer matrix and are susceptible to problems due to improper installation. Also, once these devices are exposed and function under certain fault conditions their operating characteristics may change.

### *Ceramic Type Devices*

It is difficult to describe all the variations of ceramic type controls. These controls range from devices which only measure or sense temperature increases or decreases in limited area of an application to that of providing a self limiting heat source.

There are many variations of these temperature measuring devices. These are generally categorized as PTC's (Positive Temperature Coefficient) or NTC's (Negative Temperature Coefficient). These are again used for temperature sensing applications and require additional circuitry to actually open and close an electrical circuit. These devices on generally used on low voltage DC circuits and are very accurate in their measurement capabilities.



Although some solid state controls can sense temperature, additional logic is required to do something about it. For example, a solid state device in a laptop computer can sense heat, but needs additional circuitry to tell the cooling fan to do something about it.

Other types of ceramic devices actually are used to provide a heat source for an application as well as provide for a temperature limiting function. Although the first generation of these devices was used for low wattage applications there have been advancements to permit their use on higher wattage applications. These can be used in continuous duty applications and include glue guns, curling irons, and small portable space heaters.

## Thermal Fuses

### *How They Work:*

These single operation devices work primarily as a temperature sensitive fuse. Due to their compact size and low cost they can be used as a primary protection device in applications where there is little thermal inertia experienced during normal operation conditions. Thermal fuses are also valuable as a cost effective added safety back-up to a primary operating control.

The construction of the most common form of thermal fuses basically uses a contact spring encapsulated into a wax pellet. The pellet is formulated to melt at a predetermined maximum temperature. As the wax melts the spring stretches until it breaks the circuit in the process.

Other types of thermal fuses incorporate the use of a specially formulated solder that effectively melts when exposed to given maximum temperature. These devices are non-resettable and react primarily to changes in temperature. There is some self-heating effect for these devices under higher current loads which may cause the operating characteristics to change over time.

Thermal fuses are also referred to as thermal links, thermal cut-outs (TCO's), or one shots.

### *Applications*

In many applications, these devices are commonly used to back up primary devices as required by safety agencies. Thermal fuses are effective for totally shutting down a circuit when a catastrophic failure occurs. If your application demands repeatable operation at or near the maximum operating temperature for the materials you have selected, you may want to consider using a resettable type device. Basically if you choose to use a thermal fuse as a primary operating control, then you must consider that your application will become a disposable item if the thermal fuse functions. Since thermal fuses can not be reused after functioning, it is not possible to test them before or after installation.



## *Versatility*

Even though there are limitations to how these devices perform, there are very versatile in how they can be custom tailored to meet the individual needs of a customer's application. You can choose the operating temperature range, the length of the lead wires, add terminals, add insulating sleeving, or even custom bend the standard lead wires to make your own termination points.

## **Current Sensitivity in Bimetal Thermal Controls – What You Should Know**

A major advantage enjoyed by conductive thermal controls is the ability to easily tailor them to meet your particular needs. They are extremely versatile. Start with the bimetallic element at the heart of these devices. There are literally hundreds of different types of bimetal currently available. At Portage Electric Products we have used dozens of these different bimetals to meet the various sensitivity needs of many different applications. This versatility helps conductive bimetallic devices enhance safety and prevent nuisance tripping in a wide range of applications. It even allows you to increase the ability of a thermal control to function like a circuit breaker rather than strictly functioning as a temperature control.

The major difference between bimetals lies in the internal resistance of each given type. Under an electrical load, each type of bimetal will then exhibit a different internal resistive level. This is commonly referred to as the resistivity of the bimetal. The higher the internal resistance, or resistivity of a bimetal, the more heat will be generated by the effects of the current passing through. The more heat generated, the quicker the bimetal will deflect or bend. The self-heating effect of the bimetal provides the reaction needed to function in applications where a thermal control must sense increases in either temperature and or current.

Bimetal resistivity is similar to the way water moves through a small diameter hose as opposed to a large diameter hose. The smaller hose presents greater resistance to the water's movement causing water to spurt out at a greater rate. If you use a larger diameter hose the water will face less resistance and will move through more slowly. The higher the resistivity, the faster the reaction.

The resistivity of any particular bimetal is expressed in ohms per circular mill foot (ohms cm/ft) and determines how quickly a change in temperature will make the bimetal deflect thereby breaking a circuit. The flexivity of a bimetal is the amount it bends at a certain temperature. Resistivity determines the amount of self-heat generation and aids to the speed with which a bimetal will deflect. Flexivity determines how much a bimetal will deflect under the influences of heat generation. This heat can be what is generated through the effects of heat generated by the application or through the self heating effect of current passing through the bimetal.

The other way to alter the sensitivity of a conductive bimetallic device is to vary the composition of the materials used in any other current carrying parts found in the thermal control. For example, the resistivity of the metal used in the manufacture of a support arm used to support a set of electrical contacts or used to



in conjunction with a bimetallic element, can also be increased or decreased, thereby altering the internal resistivity of the device.

### *Improving Safety*

Increasing the current sensitivity of a device will enhance the safety characteristics. The quicker a device senses a change in current, the quicker it will shut down the circuit to prevent a catastrophic occurrence. In cases where you want to alter the sensitivity of a device in order to improve safety you don't want a device to react normally. You want it to sense the danger and shut down before a serious problem occurs.

### *Avoiding nuisance tripping*

On the other hand, you don't want a thermal control to be so sensitive that it activates prematurely. There has to be a balance between too much resistivity and too little. In every case the needs of the application will determine the proper balance. A vacuum cleaner motor, for example, will have higher power needs than the blower motor in a furnace. The right thermal control might not be the same for these two motors but Pepi products can be found in both applications. Our experienced Sales Engineers will help in determining the right thermal control for your application.

## **What to Expect From Your Thermal Control Partner**

If you need a bimetallic thermostat or thermal protector, we can partner with you to make sure you get the best device for your application. Send us your product for testing. We will customize one of our thermal controls to suit the exact needs of your application and provide you comprehensive test data from our advanced Engineering Lab. We can assist you in your determination to assure the safe, reliable operation of your product.

### *The cost-saving advantages of being versatile*

By having the ability to alter the operating characteristics of our thermal controls, we can expand the number of applications for which a particular thermal control is well-suited. In this manner we can take a limited number of devices and make them perform better on any application for which a bimetallic thermal control is the best choice. This leads to lower costs for thermal controls that are better suited to a particular application.

No two electrical products are exactly alike. Neither should the thermal controls best suited to each. By giving our customers the ability to customize the operating characteristics to the exact needs of each application, you can create products that are safer, more reliable and cheaper to produce. All you have to do is understand how the versatility of these devices can work to your advantage.