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# Study of Florida Model Energy Efficiency Code For Building Construction

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1981

# STUDY OF THE FLORIDA MODEL ENERGY EFFICIENCY CODE FOR BUILDING CONSTRUCTION AND RELATED ENERGY LEGISLATION ENACTED BY THE 1980 LEGISLATURE

A REPORT TO THE DEPARTMENT OF EDUCATION
FOR RESEARCH CONDUCTED
UNDER CONTRACT NO. 081-176
ATTN: MR. CECIL GOLDEN,
ASSOCIATE DEPUTY COMMISSIONER
OF EDUCATION

PROJECT RECOMMENDED BY
THE BUILDING CONSTRUCTION INDUSTRY
ADVISORY COMMITTEE

MR. WILLIAM CONWAY, CHAIRMAN

Report by

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## FOREWARD

In 1977, the Legislature of the State of Florida enacted into law codes and/or requirements designed to insure that new buildings constructed in the State would be more energy efficient than had been previously experienced.

The 1980 Legislation changed the 1977 rules by requiring all jurisdictions within the State to adopt a uniform code entitled "The Model Energy Efficiency Code for Building Construction" hereafter referred to as the FMEE Code. The FMEE Code was modeled after ASHRAE standard 90-75 entitled "Energy Conservation in New Building Design" copyrighted in 1975 by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

Charged with the enforcement of the FMEE Code were the local building officials and building inspectors who were to refuse to issue construction permits for buildings not meeting the requirements of the code.

The 1980 Legislature supplemented the requirements of the code by enacting into law exemptions to the State sales tax plus prescriptive requirements dealing with equipment and construction techniques.

This report contains:

1. A review of those parts of the "Energy Legislation" enacted in 1980 which were found to adversely impact on the FMEE Code or which were not in accord with sound engineering practice.

2. A review of certain requirements of the code which investigation concluded were unenforceable.

3. Recommendations for possible new legislation and for changes in the FMEE Code.

## SUMMARY

### Conclusions

This study concludes:

1.1 That some of the "Energy Legislation" enacted into law in 1980 should be repealed.

1.2 That additional legislation prohibiting the sale of space heating/cooling equipment and hot water heaters not meeting the minimum requirements of the FMEE Code is required.

1.3 That some of the more technical requirements of the FMEE Code should be revised or deleted.

1.4 That minimum insulation requirements should be required by the FMEE Code.

1.5 That many requirements of the FMEE Code may not be complied with because of lack of enforcement due to:

a. Inadequate manpower
b. Lack of technical expertise of building officials

1.6 That additions to residential structures currently exempt from provisions of the FMEE Code be made to comply with the Code.

### Recommendations

2.1 House Bill 1506 should be revised to allow all "super" high efficiency air conditioning units and heat pumps to be exempt from the Florida sales tax - or that section of House Bill 1506 should be repealed.

2.2 The requirement of House Bill 1506 pertaining to the installation of heat traps on hot water heaters should be repealed.

2.3 The requirements of House Bill 1506 pertaining to stand by losses of gas fueled water heaters should be repealed.

2.4 The requirements of House Bill 1506 pertaining to the installation of time clocks on electric hot water heaters should be repealed.

2.5 The requirements of House Bill 347 pertaining to the installation of connections on hot water heating piping for connection to future solar or heat recovery systems should be repealed.

2.6 Prescriptive legislation should be enacted prohibiting the sale, in the State of Florida, of space heating/cooling and hot water heating equipment which does not meet the minimum requirements of the FMEE Code.

3.1 The FMEE Code should be revised to require a minimum of R-19 insulation in ceilings or roofs of all new buildings not exempt from the Code.

3.2 The FMEE Code should be revised to require a minimum of R-2.75 insulation in the exterior walls of all new buildings not exempt from the Code.

3.3 The FMEE Code should be revised to require a minimum of R-11 insulation in floors built over crawl or unconditioned spaces.

3.4 The FMEE Code should be revised so that the thermostats specified in Section 503.7(a) be required for non-residential buildings only.

3.5 The first sentence of the first paragraph of Section 503.5 of the FMEE Code which now reads:

> "The air transport factor for each all-air HVAC system <u>shall</u> not be less than 8.0"

should be changed to read:

> "The air transport factor for each all-air HVAC system <u>should</u> not be less than 8.0."

3.6 The FMEE Code should be revised to require that all additions to residential structures conform to the minimum requirements for insulation in walls, floors, roofs and/or ceilings.

3.7 The FMEE Code should be revised to prohibit the use of electric resistance heating in all-air HVAC systems including supplementary duct heaters used in conjunction with heat pumps.

3.8 The FMEE Code should be revised to increase the combustion efficiency of gas and oil fired hot water heaters from 70% to 75%.

4.1 Change all requirements in the FMEE Code which cannot be enforced into design recommendations.
Institute a training program for building inspectors on methods for checking compliance with the FMEE Code.

Discussion

2.1

House Bill 1506 exempts certain "super" high efficiency HVAC equipment from the State of Florida sales tax. Not exempt are cooling only units which use electric resistance elements as the primary source of heating.

It would appear that the primary motive for the passage of this piece of legislation was to encourage the purchase of high efficiency equipment by offsetting the higher cost of the equipment with a rebate of the 4% sales tax.

A preliminary version of this report stated:

> "In the '1980 Instruction Manual for Sections 8,9 and 9M' issued by the Governor's Energy Office and dated May 1980, it states (page 8)
>
> > 'Whereas in region 7, 8 and 9, (Charlotte, Broward, Dade countries, the Keys etc.) it makes more sense to specify a super high efficiency air conditioning unit and electric strip heat or gas heat' (rather than to install a heat pump).
>
> Assuming that the above statement is technically correct, homebuyers in regions 7, 8 and 9 are being discriminated against by the State if their builder tries to follow the advice of the energy office. In addition, the ability to enforce this provision is questioned."

Since this report will recommend the prohibition of electric strip heaters in forced air systems (See Section 3.7) the preliminary comments are no longer valid.

The recommendation is to revise this section of the Bill to include all "super" high efficiency units - or repeal the whole provision.

Discussion

2.2 House Bill 1506 states:

> "Water heaters sold for residential use, after October 1, 1980, shall be installed with a heat trap.........."

A heat trap is a device (see Figures 1 and 2) installed on the hot water (discharge) side of a hot water heater tank which is intended to prevent gravity water circulation in a dead ended piping system due to the difference in density (weight) between hot and cold water.

In the normal plumbing system, hot water remaining in the pipe between the hot water tank and the plumbing fixture (sink, lavatory, bath tub, etc.) valve will cool down after the valve is closed. In doing so, the cooler water will become heavier than the warmer water in the hot water tank, will flow back to the tank (if the tank is at a lower elevation), and be replaced by hot water rising from the tank. The hot water will, in turn, lose heat and the process, just described, will repeat itself.

If this situation occurs, and if the hot water piping is run in the interior walls, or in the ceiling between floors of a building, the heat lost from the hot water pipes will reduce the heating requirements of the structure in the winter. In the summer, however, we not only lose the heat energy from the hot water but must remove this heat from the structure with the cooling system.

The majority of buildings constructed in Florida are one-story single family residential units most commonly built slab-on-grade or over a crawl space. Hot and cold water distribution piping is normally run under the floor or floor slab. The hot water pipes from the hot water tank form a natural "heat trap" which prevents water circulation without the addition of any "store-bought" plumbing fittings (see Figure 3).

Without either testing purchased "heat traps" or receiving reliable test reports, it is doubtful that heat traps of the type offered for sale by Trenton Pipe Nipple Company and others will produce the results claimed.

What remains are a small number of two or three-story private residences, apartment buildings where each tenant has their own hot water heater, hotels and motels, commercial and multi-story office buildings.

Since tourism is a major industry in this State - hot water systems should be designed with a re-circulating hot water system so that hot water is available when the guests desire it without a long wait and without wasting a large quantity of water. In this situation a "heat trap" should not be installed.

Multi - story office buildings usually served by a single hot water tank would also be designed with a re-circulating hot water system since

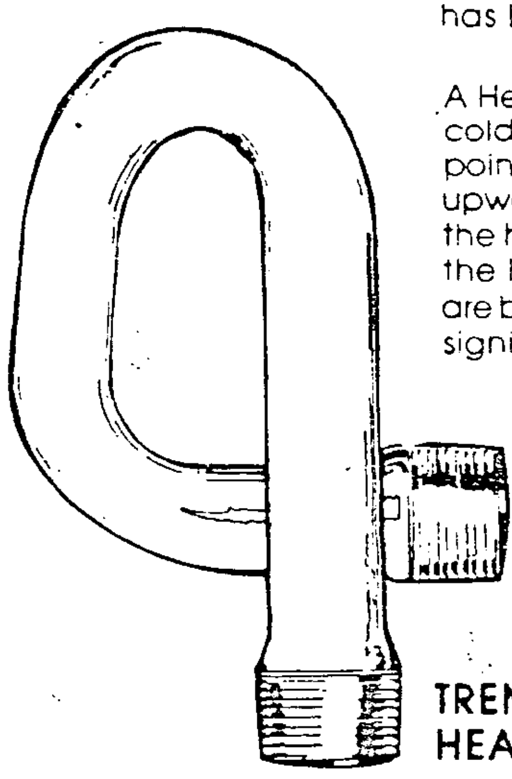
# THE TRENTON HEAT TRAP

The purpose of a Heat Trap is to significantly reduce heat loss due to radiation from the piping leading from a water heater.

The typical water heater has the hot water outlet at the top. From the outlet there is a short vertical run, a 90° elbow, and then a long horizontal run. The heat from the water in the horizontal run is radiated to the surrounding room, and the water in the pipe cools. Convection currents are then set up within the piping. The cool water in the horizontal run being denser flows downward into the heater. The hot water in the heater, being less dense, flows upward into the horizontal run, where its heat is then radiated into the room and the cycle repeated. Thus, even when there is no water flowing in the system, heat is being lost not only through the walls of the heater but also through the piping system.

A Heat Trap is a piping configuration where the outlet is located some distance below the high point. (The vertical distance between the high point and the outlet is called the "drop" of the Heat Trap and is the significant measure of its efficiency.) The Trenton Heat Trap design has been tested and proven.

A Heat Trap works because hot water is less dense than cold water. The outlet of the Heat Trap is below its high point, so the cold water from the piping will not flow upward from the outlet to its high point. The hot water in the heater will not flow downward past the high point of the Heat Trap into the piping. Thus the convection currents are broken and heat loss through the piping significantly reduced.



TRENTON
HEAT TRAP #HT-12

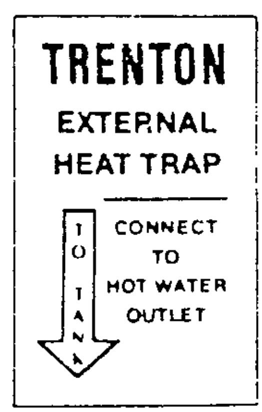



Figure 1

ALL TRENTON HEAT TRAPS ARE LABELED INDICATING PROPER END TO CONNECT TO TANK, TO ENSURE ENERGY-EFFICIENT INSTALLATION

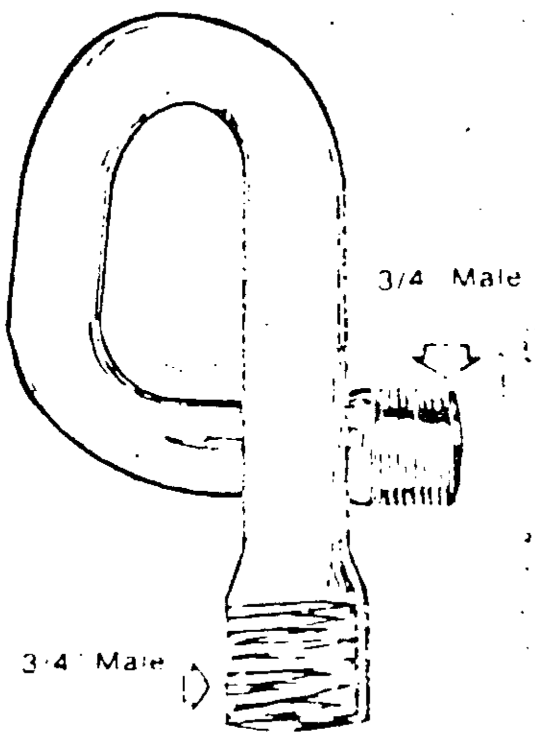
Unit Carton 12
Master Carton 72
Bulk (No Unit Cartons) 250 Per Shipping Container

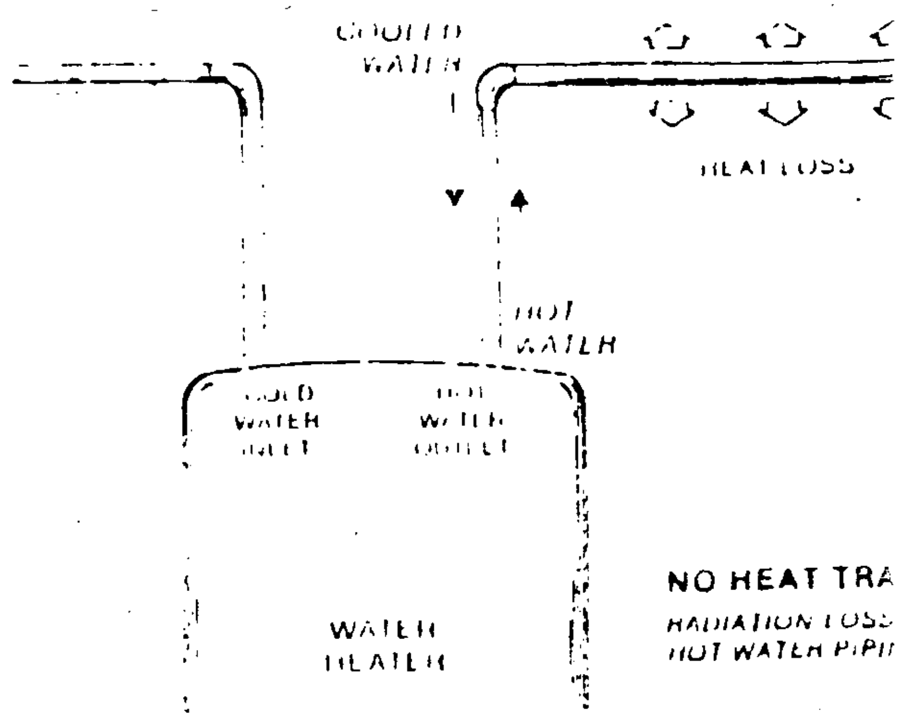
TRENTON
PIPE NIPPLE
COMPANY

# heat trap

## Trenton's External Heat Trap for Water Heaters Eliminates Convection Currents, Reduces Piping Heat Loss, Conserves Energ

MADE FROM 1/2"
SPS BRASS PIPE



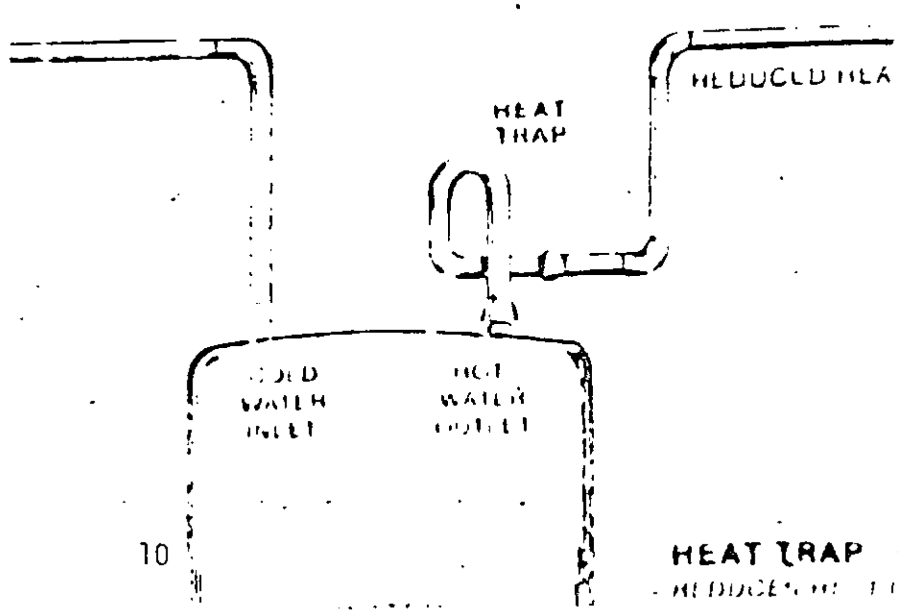




Figure 2

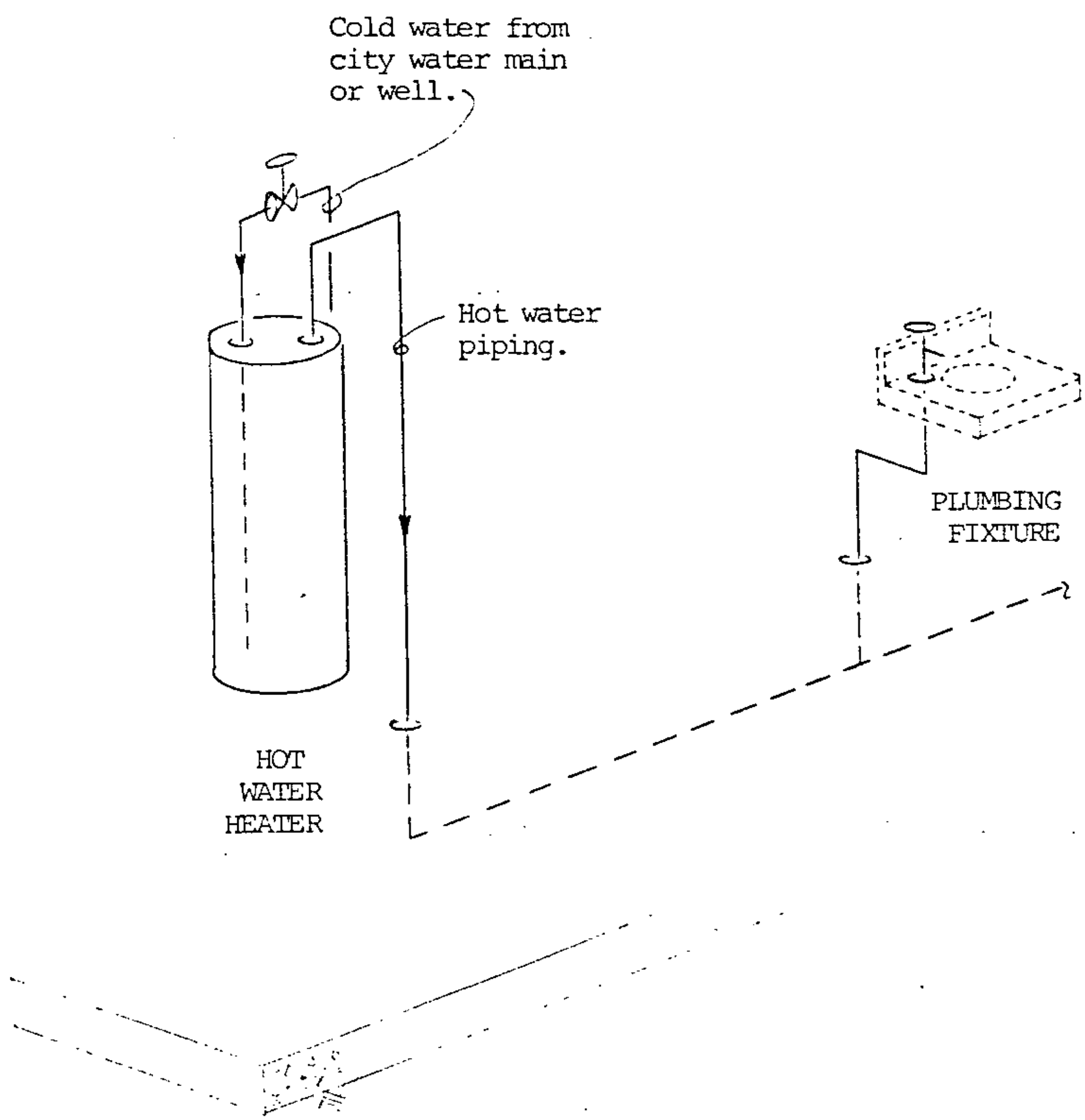



Figure 3

Typical Hot Water Piping Arrangement
for Slab-on-Grade Construction

Discussion - 2.2 Continued

the energy required to treat the water which would be wasted waiting for the hot water to emerge from the faucet would probably equal the energy lost by the piping system.

Since only a tiny fraction of new residential buildings would benefit from the installation of a "heat trap" it seems illogical to require, by statute, that all buildings have them.

The recommendation, therefore, is to repeal this portion of House Bill 1506.

Discussion

2.3

House Bill 1506 states:

> "Water heaters fueled by natural gas or liquified petroleum gas in any form sold or installed after March 1, 1981, shall have a recovery efficiency of 75% or more and a standby loss in percent per hour not exceeding the number determined by dividing 67 by the volume of the tank in gallons and adding the result to 2.8."

ASHRAE 90-75 requires, effective January 1, 1977, a minimum recovery efficiency of 75% (as did the early edition of the FMEE Code). The FMEE Code issued October 1, 1980 requires an efficiency of 70%.

It was originally contemplated to investigate the reasons for differences between the statute and the FMEE Code. However, a survey has indicated that the majority of gas fired water heaters available for sale meet the requirement of House Bill 1506 with regard to combustion efficiency.

Using the Relationship:

$$EFF = \frac{\text{Heat Output } \frac{(BTU)}{(HR)}}{\text{Heat Input } \frac{(BTU)}{(HR)}}$$

$$= \frac{(\text{Gal/Hr})\ (\text{Temp Rise-}^\circ\text{F})(1)(8.33\#/\text{Gal})}{\text{Heat Input}}$$

The investigation revealed the following for a 30 gallon gas fired water heater:

| Retailer | Heater Mfgr | Recovery Rate @90°F Rise | Heat Input BTU/Hour | Efficiency |
|---|---|---|---|---|
| Sears & Roebuck | Unknown | 34.9 GPH | 34,000 | 76.95% |
| Hughes Supply | Rudd | 32.8 GPH | 32,000 | 76.84% |
| West | Craftmaster | 34 GPH | 33,000 | 77.24% |

Since it appears that units are available to meet the 75% efficiency requirement - the FMEE Code requirement should be changed from 70% to 75%.

Discussion - 2.3 Continued

ASHRAE 90-75 and the FMEE Code require hot water heaters to have a standby loss (loss of heat energy from the water inside the tank thru the insulation to the surrounding air) no greater than 67 divided by the tank volume in gallons plus 2.3.

Maximum loss allowed by:

House Bill 1506

$$L = \frac{67}{\text{Tank Volume}} + 2.8$$

FMEE Code

$$L = \frac{67}{\text{Tank Volume}} + 2.3$$

As indicated above, House Bill 1506 would allow a greater standby less than the FMEE Code. It is therefore obvious that this portion of Bill 1506 should be repealed.

The investigation of hot water heaters also revealed that the heaters (both gas and electric) sold by Sears, West and Hughes Supply bore a label indicating that they meet the requirements of ASHRAE 90-75.

This investigation also revealed that Lowe's of Gainesville had hot water heaters for sale which did not meet the requirements of either House Bill 1506 or the FMEE Code. In addition, the Sear's 1981 Fall and Winter catalog lists water heaters (not meeting the FMEE Code) which cannot be sold in the states of California, New York, Oregon or Virginia but can be presumabely sold in Florida.

For additional discussion see Sections 2.6 and 3.8.

Discussion

2.4

House Bill 1506 states:

> "Electric water heaters equipped with resistance elements as the primary heat source shall be installed with a 24-hour timer, but the timer requirements of this subsection shall not apply to any electric water heater whose standby loss does not exceed 4 watts per square foot of tank surface per hour."

The FMEE Code requires, in Section 504.2, that all automatic electric storage heaters(s) have a standby loss not exceeding 4.0 watts/$ft^2$ of tank surface area.

Since the FMEE Code already requires high efficiency insulation, the only instances where the installation of a time clock could even apply is:

a. Where replacement heaters not meeting the standby loss requirements of the FMEE Code are being installed.

b. Where alterations to buildings or to building systems are being made the cost amounting to less than 30% of the appraised value of the structure and non-conforming heaters are being installed.

In the two instances cited above, the installation either would not be inspected by the local building department (case a) or would not fall under the requirements of the code (case b).

According to a study made by Gulf Power, the addition of an insulating blanket around non-code conforming water heaters is more cost effective than the installation of a 24-hour timer. Because of this, and because this report will recommend that no non-conforming water heaters be offered for sale in the State of Florida the recommendation is that this provision of House Bill 1506 be repealed.

## Discussion

2.5

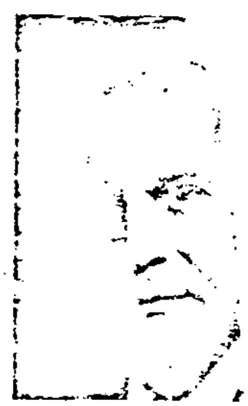
House Bill 347 states in part:

> "Solar water heating and waste heat recovery requirement.---Notwithstanding the provisions of ss 553.12 and 553.13, buildings for which a building permit is obtained after October 1, 1980, shall be constructed with plumbing designed to facilitate the future installation of solar and waste heat recovery equipment for water heating. The phrase "facilitate the future installation" means the provision of readily accessible piping and pipe fittings to permit easy connection of solar and waste heat recovery equipment for water heating........."

The requirements of this piece of legislation is similar to a bill passed in 1974 and signed by the then Governor Reubin Askew.

10-B St. Petersburg Times, Tuesday,

# Solar plumbing law set



WILLIAM GILLESP
... sponsored bill

TALLAHASSEE (P — All homes built in Florida after Oct. 1 must have plumbing to accommodate solar water heaters, under a law signed Monday by Gov. Reubin Askew.

The sponsor of the bill, Sen. William Gillespie, D-New Smyrna Beach, said the law was needed because of the high cost of modifying plumbing in already-built houses when installing solar water heaters.

**A BILL REQUIRING** that the number 911 be established as a common emergency number in all areas around the state also was signed into law by the governor.

programs be establish train family physicians.

✓ Require that pri schools post bonds to tuitions if the school close.

**ALSO SIGNED** into a bill establishing cri in Jacksonville, P and Tampa to join the currently in Tallahas providing $232,000 state to pay half the c

CLIPPING FROM THE ST. PETERSBURG TIMES

Figure 4

Discussion - 2.5 Continued

The 1974 Bill was the first piece of solar energy related legislation passed by any state in the nation and it is still on the "books". This Bill specifically required that all hot water heaters in new buildings:

a. be provided with a shut-off valve on the cold water supply to the hot water heater.

b. be provided with plugged tees on both the cold water inlet and hot water outlet pipes of the hot water heater tank.

House Bill 347 while vague in it's language, is nothing more than a restatement of the Bill passed in 1974.

Casual conversations with plumbing inspectors of various municiple and county building departments indicated that the requirements of the 1974 Bill were never enforced (even by those inspectors who were familiar with the legislation) because:

a. the major provision requiring the shut-off valve was already a requirement of local plumbing codes.

b. The addition of connections for solar systems could be easily and inexpensively accomplished at the time the building is retrofitted for solar or heat recovery.

The recommendation is therefore to repeal this portion of House Bill 347.

Discussion

2.6

The provisions of the FMEE Code cover new construction and existing structures undergoing renovation where the estimated cost of the renovation exceeds 30% of the assessed value of the structures.

In the City of Gainesville two apartment complexes, each having 40 apartments, had completely new heating and cooling systems installed in 1980 and 1981. Since the cost of the renovation did not exceed 30% of the structures assessed value the new equipment installed was not required to conform to the Code. There now exists 80 apartments in Gainesville which will add an unnecessary burden on the local utility company.

In addition, the average life of air conditioning equipment (specifically the compressor) and hot water heaters is between 10 and 15 years. Large numbers of low efficiency units installed before 1970 will soon be ready to be replaced. The number of units replaced in future years will probably exceed the number of units installed in new construction as can be seen in the following table.

| Year | Number of Residential Units Constructed in Florida |
|---|---|
| 1965 | 73,281 |
| 1966 | 66,594 |
| 1967 | 73,971 |
| 1968 | 107,626 |
| 1969 | 123,496 |
| 1970 | 106,198 |
| 1971 | 161,585 |
| 1972 | 283,900 |
| 1973 | 266,982 |
| 1974 | 110,794 |
| 1975 | 47,989 |
| 1976 | 66,691 |
| 1977 | 108,052 |
| 1978 | 147,885 |
| 1979 | 173,345 |
| 1980 | 143,600 |

The recommendation therefore must be prescriptive in nature and must be mandated by the Legislature and not the FMEE Code. This Legislation should prohibit the sale, in the State of Florida, of space heating/cooling and hot water heating equipment not meeting the minimum requirements of the FMEE Code.

## Discussion

3.1

Most buildings constructed in the State of Florida are either built with flat or pitched roofs.

In flat roof construction, the insulation is either an integral part of the roof deck, or is placed over the ceiling below.

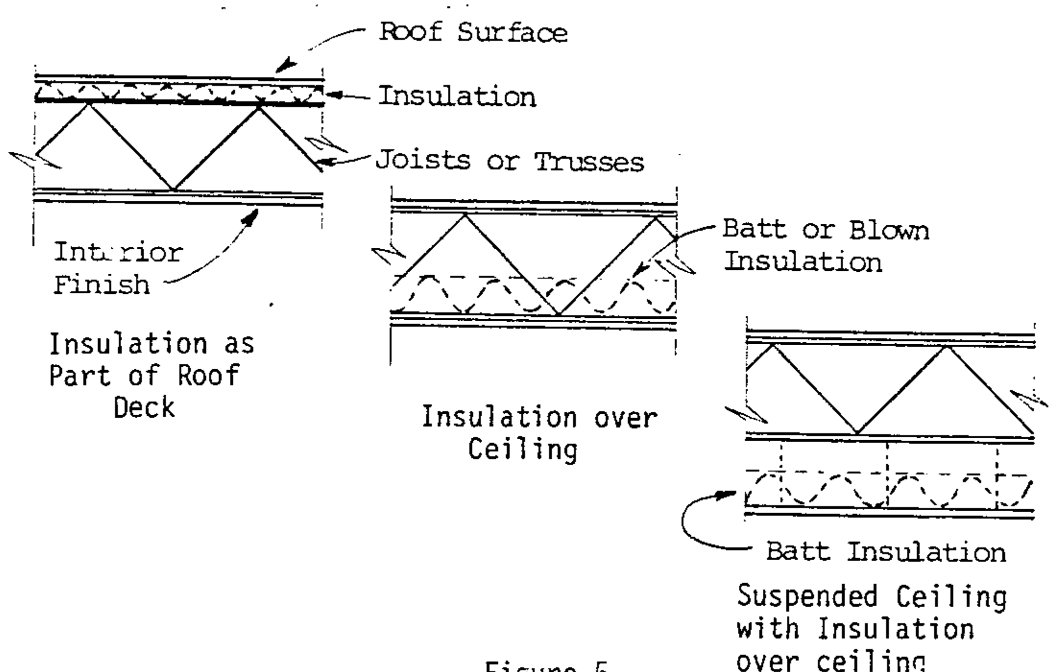



Figure 5

Typical Flat Roof Construction

Discussion - 3.1 Continued

If the insulation is incorporated as part of the roof deck or is placed above a ceiling which is directly fastened to the lower member of the joist or truss it is virtually impossible to add additional insulation without an extensive and costly re-working of the roof or ceiling.

In pitched roof construction, the roof insulation is also either an integral part of the roof deck or is placed over the ceiling below.

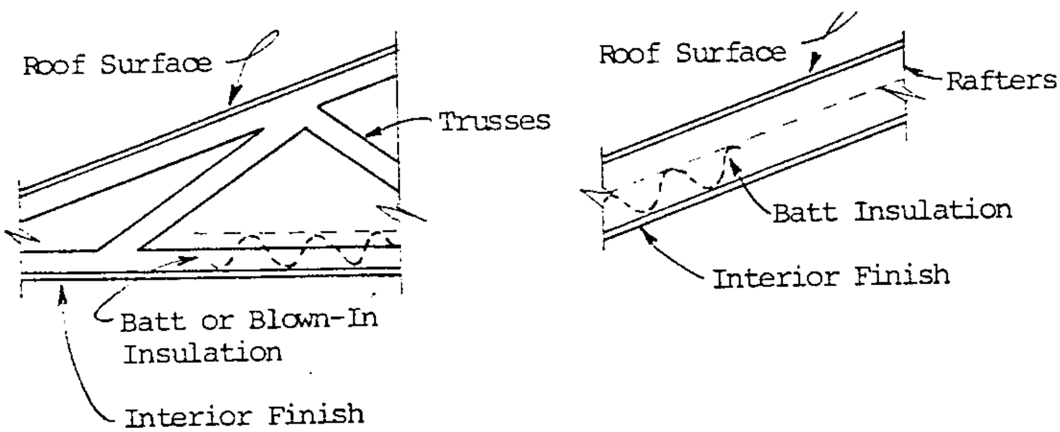



Figure 6

Typical Pitched Roof Construction

Discussion - 3.1 Continued

If the insulation is incorporated as part of the roof deck or is placed above a ceiling which is directly fastened to the lower portion of the rafter, it is virtually impossible to add additional insulation without an extensive and costly re-working of the roof or ceiling. Even with pre-fabricated truss construction, if the pitch of the roof is less than 5 in 12, it is extremely difficult to add additional insulation except, of course, for the loose-fill type which is blown-in.

If a calculation is made for the heat gain thru an average size Florida residence we find the following:

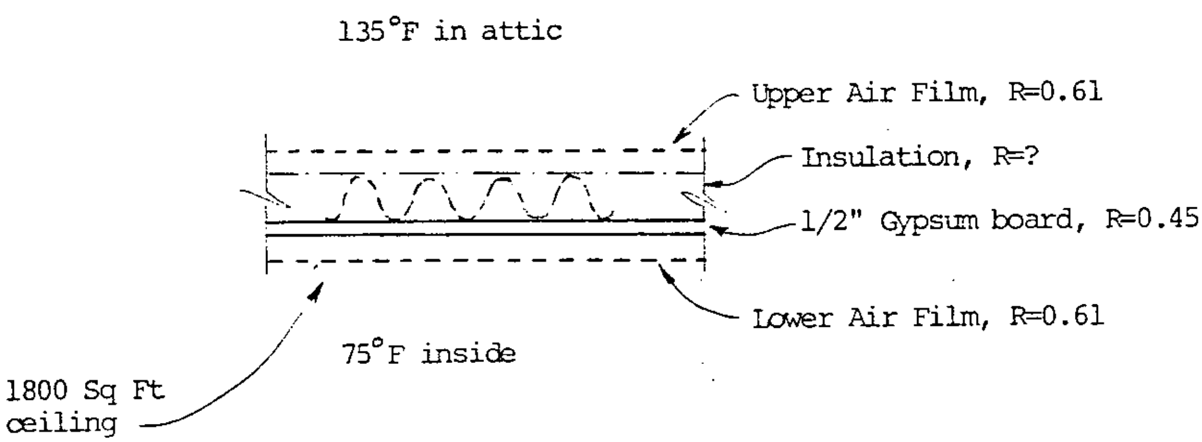



Figure 7

Cross-Section Thru Ceiling

of Typical Florida Residence

Discussion - 3.1 Continued

| Insulation Tkn. | Total Resistance | Heat Gain BTU/Hr | Heat Gain Compared To Ceiling W/O Insul. | % Saving Compared To Ceiling W/O Ceiling | % Saving Per Additional 3½" of Insulation |
|---|---|---|---|---|---|
| 0 | 1.67 | 64,671 | - | - | - |
| 3½" (R-11) | 12.67 | 8,524 | 56,147 | 86.8% | - |
| 6 " (R-19) | 20.67 | 5,224 | 59,447 | 91.9% | 5.1% |
| 9 " (R-30) | 31.67 | 3,410 | 61,261 | 94.7% | 2.8% |
| 12 " (R-38) | 39.67 | 2,722 | 61,949 | 95.8% | 1.1% |

The data presented above indicates (ignoring the addition of insulation to the un-insulated ceiling) that the effectiveness of additional increments of insulation decreases after the installation of 9" of fiberous glass insulation.

In Florida, since the more popular builder supply companies do not carry 9" thick insulation, to accomplish an R-30 value a combination of 6" batt and 3" of blown must be used which increases the installation cost.

The recommendation is therefore to have the FMEEC require a minimum thickness of insulation equivalent to R-19 in all roofs or over all upper floor ceilings.

Discussion

3.2

Most buildings constructed in the State of Florida have exterior walls of masonary or frame construction.

Frame construction is generally accomplished using vertical 2"x4" or 2"x6" wood studs spaced on 16" and 24" centers respectively. Spaces between the studs are normally filled with batt type insulation.

Masonary walls (cement block ) either have no interior finish or have an interior finish consisting of drywall, plaster, or paneling fastened to 1"x2" furring strips which have been nailed to the inside surface of the block wall. The furring strips effectively form a 3/4-inch void or air space behind the interior finish. Prior to the enactment of the FMEE Code into law the voids were usually unfilled. Under the provisions of the FMEE Code, "block" walled buildings with an air space between the furring strips can and do comply with the requirements. To add insulation to the wall at a later date is a virtual impossibility without removing and replacing the interior drywall, plaster, or paneling.

The fact that filling the void between the furring strips with insulation may not improve the wall's thermal response in the summer due to the mass effect of the masonary is recognized. The addition of inexpensive expanded polystyrene insulation, R-2.8, (material cost approximately 13 cents/ft$^2$) will reduce heat losses in the winter thru masonary walls by approximately 25%. The total increase in cost for the average 1800 square foot house should be no greater than $200.00.

The recommendation is therefore to have the FMEE Code require a minimum thickness of insulation equivalent to R-2.75 in all walls.

## Discussion

3.3

Section 502.2(a) - 2 (Type A1 and A2 Residential Buildings) and Section 503.3(a) - 2 (All Other Buildings) require a minimum thermal resistance for floors over unheated spaces of 3.33 for Type A1 and A2 Buildings and between 3.33 and 2.5 for other buildings depending upon the climate area.

An unfinished wood floor without insulation over a crawl or unheated space has a thermal resistance of 2.5. This type of installation satisfies the requirements for Zone 9 (the Keys).

The addition of carpeting and a rubber pad would increase the total resistance to 3.7 and would now meet the minimum thermal requirements for any type building in any location in Florida.

ASHRAE Handbook - 1981 Fundamentals states:

> "A crawl space can be considered a half basement. To prevent the ground moisture from...causing a condensation problem..., most of the crawl spaces are required to be adequately vented all year around. However, venting the crawl space in the heating season does bring the crawl space temperature close to that of the outdoor air temperature. This may cause substantial heat loss from the indoor space."

Since the floor area over a crawl space is equivalent to the ceiling area, it would seem only logical to provide somewhat equivalent thermal resistance in both the floor and ceiling/roof.

The recommendation is therefore to have the FMEE Code require a minimum of R-11 in all floors over crawl or unheated spaces.

## Discussion

3.4

Section 503.7 (a) of the FMEE Code states:

> "Temperature Control. Each HVAC system shall be provided with at least one adjustable thermostat for the regulation of temperature. Each thermostat shall be capable of being set as follows:
>
> 1. Where used to control heating only, a maximum temperature setting of 75F.
>
> 2. Where used to control cooling only, a minimum temperature setting of 70F.
>
> 3. Where used to control both heating and cooling, it shall have a maximum heating mode temperature setting of 75F and a minimum cooling mode temperature setting of 70F and shall not be capable of operating the system heating and cooling simultaneously. It shall be adjustable to provide a temperature range of up to 10F between full heating and full cooling, except as allowed in 503.3 (c) 4b."

The response to the survey questions pertaining to this requirement of the Code was:

1. 42% of those responding indicated that they did not check for compliance.

2. 54% of those responding indicated either that this requirement be deleted from the Code or that they had no opinion on leaving it in or out.

In order to meet the requirement for a structure which is both heated and cooled (which is the case for practically all buildings constructed in Florida) a double or dual thermostat (essentially two units in one) usually must be used.

This investigation determined that there are at least four manufacturers who produce thermostats purporting to meet the requirements of the Code. They are:

1. Barber Coleman - See Figure(s) 8 & 9
2. General Electric Co. - See Figure(s) 10 & 11
3. Honeywell, Inc. - See Figure(s) 12 & 13
4. Johnson Controls - See Figure(s) 14, 15, 16 & 17

# Two-Position Electric Duplex Thermostats
# Heating/Cooling Energy Deadband

## THE TC-1161 SERIES

This series features **two complete thermostats** under one cover with two setpoints and two dial ranges

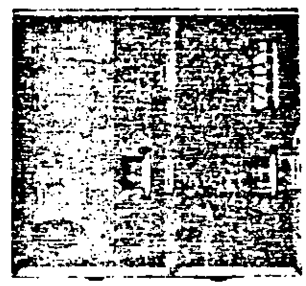
The TC-1161 can be used with an AT-600 sub-base or automatic day/night switch on heating-only systems to provide night setback.

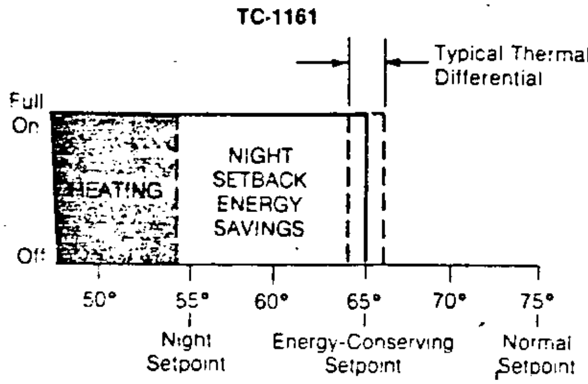
The TC-1161-497, -530 and -531 can be used with an AT-600 sub-base or aquastat on heating/cooling systems to provide a positive changeover between heating and cooling modes.

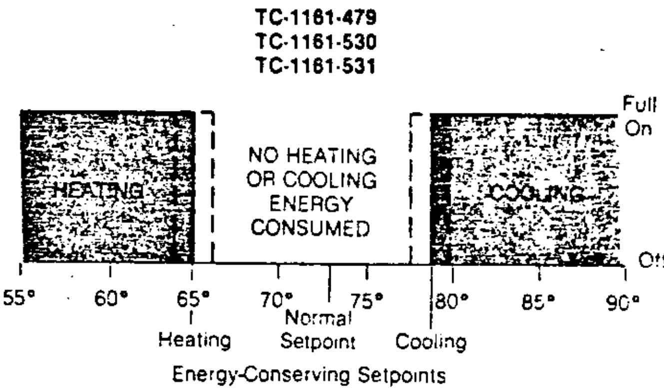
A deadband can be established between heating and cooling, in which no energy is consumed.

Dial stop pins allow field locking or limiting of setpoint.

**Energy-conserving dial ranges** keep the thermostat from being set unnecessarily high or low.






## HOW YOU CAN SAVE ENERGY

- **Save approximately 3% per degree** by lowering the heating setpoint.
- **Save cooling energy** by raising the cooling setpoint.
- **Eliminate the temptation to set thermostats unnecessarily high or low** with special energy-conserving dial ranges.
- Be sure you **realize projected savings** by locking in your energy-conserving setpoint with dial stop pins.
- **Save up to 16% annually** using a 10°F night setback.
- **Consume NO heating or cooling energy when space temperatures are in a comfortable range.** Establish an energy deadband between heating and cooling modes.
- **Increase system efficiency** by preventing heating and cooling equipment from operating simultaneously.

## PRODUCT FEATURES

- Factory or field setpoint adjustment **meets ASHRAE guidelines.**
- Cover options provide **setpoint security** and help you **realize your projected energy savings:**
  - External, internal or key setpoint adjustment
  - Locking cover on internal adjustment
  - Optional dial stop pins
  - Exposed, concealed or omitted thermometer
- Heat and cold anticipation (standard on TC-1161-530, -531) **improves occupant comfort.**
- Optional night setback provides **substantial energy savings.**

| Normal Application | Switch Action | Dial Range | | Part No. |
|---|---|---|---|---|
| | | Left | Right | |
| Heating with Night Setback | SPDT (2) | 55–85°F | 55–85°F | TC-1161 |
| Low or Line Voltage Heating/Cooling | SPST (2) | 75–100°F (cooling) | 55–75°F (heating) | TC-1161-479 |
| Low Voltage Heating/Cooling | SPST (2) | 75–100°F (cooling) | 55–75°F (heating) | TC-1161-530 |
| Line Voltage Heating/Cooling | SPST (2) | 75–100°F (cooling) | 55–75°F (heating) | TC-1161-531 |

Figure 8

# Proportional/Two-Position Electric Duplex Thermostats Heating/Cooling Energy Deadband

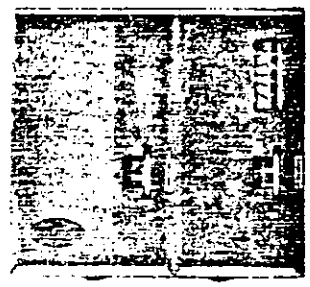
## THE TPC-10000 SERIES

This series features two thermostats under one cover with two setpoints, two dial ranges and two outputs.

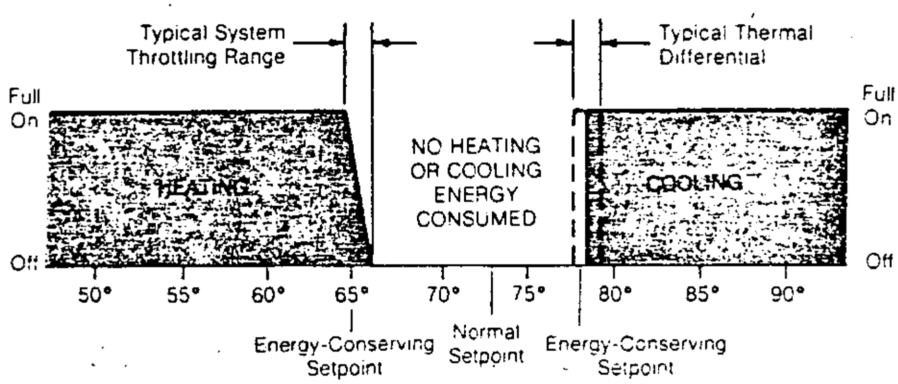
One thermostat is a **proportional Microtherm**®; the other is a two-position SPDT thermostat. The user can select proportional control for heating and two-position control for cooling (or night fan operation); alternately, proportional cooling control and two-position heating control are available.

A positive changeover between heating and cooling is required, and an **energy deadband** between heating and cooling can be established.

Dial stop pins allow field locking or limiting of setpoint. Energy-conserving dial ranges keep the thermostat from being set unnecessarily high or low.



**PROPORTIONAL HEATING, TWO-POSITION COOLING**




**PROPORTIONAL HEATING, TWO-POSITION COOLING**

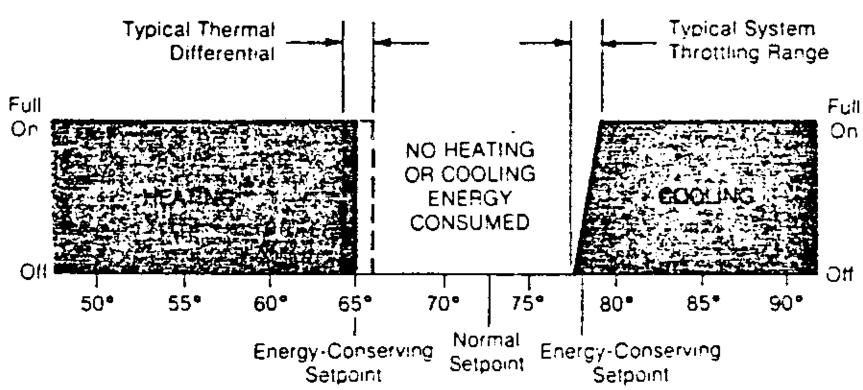



Figure 9

# (BAY28X161) WEATHERTRON® THERMOSTAT (MANUAL)

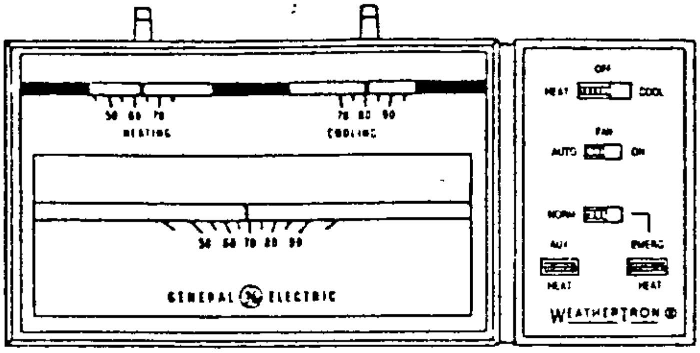



Figure 1. BAY28X161 Thermostat

## SPECIFICATIONS

Type: Weathertron® Thermostat Cat. No. BAY28X161 Featuring Outdoor Anticipation.

Range: 45°F. to 75°F. on heating cycle. 70°F. to 95°F. on cooling cycle. There are mechanical stops to prevent lever setting for heating above 75°F. and cooling below 70°F.

Adjustment Means: Separate setting lever for heating and cooling control. 5°F. minimum difference between heating and cooling, and 1.5°F. maximum difference between the two heating stages.

Scale Markings: 5 degrees per division, numbered every 10 degrees.

Dimensions: 6.3" x 2.75" x 1.94".

Finish: Gold and dark brown.

## INSTALLATION

Location: Locate the thermostat on an inside wall, since the temperature of outside walls varies with outdoor conditions.

The position on the inside wall must not be less than 18 inches from the junction with an outside wall.

The location should permit a free flow of room air over the thermostat.

The vertical location should be between three and five fe above the floor. The lower mounting has the advantage being more nearly in the zone of occupancy but is subject furniture interference and to tampering by children.

Having made a tentative selection of the best mounting l cation, check against the following possible objections;

(a) Steam pipes, water pipes, or warm air stacks in adj cent partition space.
(b) Cold, unused room on opposite side of partition.
(c) Kitchen range on opposite side of partition.
(d) Subject to radiation from fireplace or direct sun effe from windows.
(e) Subject to drafts from stairwells or outside doors.
(f) In direct path of air currents from air delivery registe:
(g) Heat from nearby floor lamps, radios, or televisi sets.

Try to determine more than one desirable thermostat loc tion. Then let the home owner make the final choice of o: of the good thermostat locations you have selected.

## MOUNTING AND WIRING

1. The thermostat is specially packed for shipment. Ho ever, it must be handled carefully.
2. After checking the wiring diagrams and electrical conne tions run the low-voltage cable to the thermostat location.
3. Lead the 24 volt cable through the large opening in th sub-base to the terminals indicated in Fig. 2.
4. Fasten the sub-base to the wall. Care must be taken mount the thermostat in a level position for proper oper tion of the calibrated mercury switches. It is suggested that carpenter's level be used to facilitate this leveling. Conne leads to sub-base terminals per hook-up diagram of the Uni Push excess cable back into wall and plug wall opening wit putty or caulking material to prevent drafts from affecti thermostat. Mount thermostat onto sub-base and tighten a circuit screws.

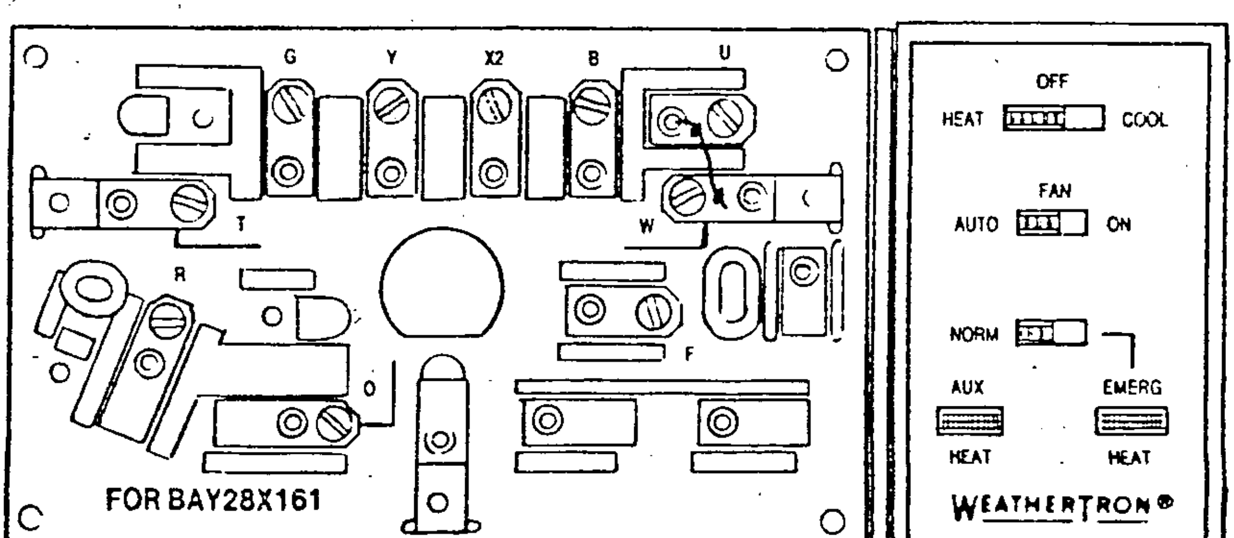



Figure 10

# INSTALLATION INSTRUCTION

(INFORMATION CONTAINED IN THIS INSTRUCTION SUBJECT TO CHANGE WITHOUT NOTICE)

18-HD19D1
1st. Printing 1979

# BAY28X163 HEATING/COOLING THERMOSTAT

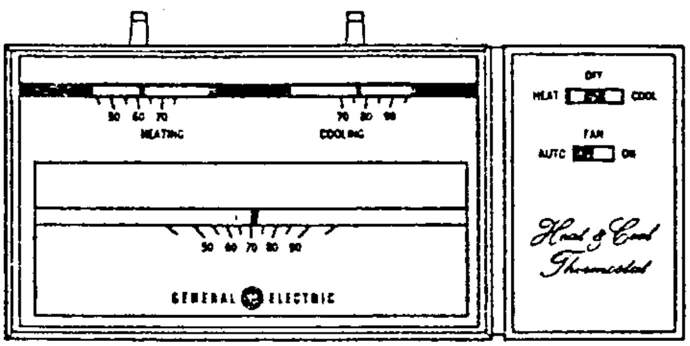



FIGURE 1. BAY28X163 THERMOSTAT

## SPECIFICATIONS

Type: Heat/Cool Thermostat Cat. No. BAY28X163.

Range: 45°F to 75°F on heating cycle. 70°F to 95°F on cooling cycle. There are mechanical stops to prevent lever setting for heating above 75°F and cooling below 70°F.

Adjustment Means: Separate setting levers for heating and cooling control. 5°F minimum difference between heating and cooling.

Scale Markings: 5 degrees per division, numbered every 10 degrees F.

Dimensions: 6.3" x 2.75" x 2.09".

## LOCATION

Location: Locate the thermostat on an inside wall, since the temperature of outside walls varies with outdoor conditions.

The position on the inside wall must not be less than 18 inches from the junction with an outside wall.

The vertical location should be between three and five feet above the floor. The lower mounting has the advantage of being more nearly in the zone of occupancy but is subject to furniture interference and to tampering by children.

The location should permit a free flow of room air over the thermostat.

Having made a tentative selection of the best mounting location, check against the following possible objections:

1. Steam pipes, water pipes, or warm air stacks in adjacent partition space.
2. Cold, unused room on opposite side of partition.
3. Kitchen range on opposite side of partition.
4. Subject to radiation from fireplace or direct sun effect from windows.
5. Subject to drafts from stairwells or outside doors.
6. In direct path of air currents from air delivery registers.
7. Heat from nearby floor lamps, radios, or television sets.

Try to determine more than one desirable thermostat location. Then let the home owner make the final choice of one of the good thermostat locations you have selected.

## MOUNTING AND WIRING

Having selected the most desirable location, proceed with mounting and wiring.

1. The thermostat is specially packed for shipment. However, it must be handled carefully.
2. Remove cover from the thermostat. See Figure 1.
3. Remove the three (3) screws securing thermostat to sub-base. See Figure 3.
4. Mark the two mounting holes using the sub-base as a template, see Figure 2. Locate cable hole between the two mounting holes.
5. Drill the three (3) holes previously marked on the wall. **CAUTION: Disconnect Power.**
6. After checking the wiring diagrams and electrical connections run the low-voltage cable to the thermostat location.
7. Lead the 24 volt cable through the large opening in the sub-base. See Figure 2.
8. Fasten the sub-base to wall with screws provided, or with 2 No. 6 - 32 x ½" pan head screws if attached to a wall box. Care must be taken to mount the thermostat in a level position for proper operation of the calibrated mercury switches. It is suggested that a carpenter's level be used to facilitate this leveling.

**CAUTION: Strip wires 1/4" back. Do not permit naked wires to touch any metal components at base.**

9. Connect leads to sub-base terminals per field wiring diagram of unit. Push excess cable back into wall and PLUG WALL OPENING WITH PUTTY OR CAULKING COMPOUND to prevent drafts from affecting thermostat. Tighten all circuit screws and mount thermostat onto sub-base and secure with screws removed in step 3 above.

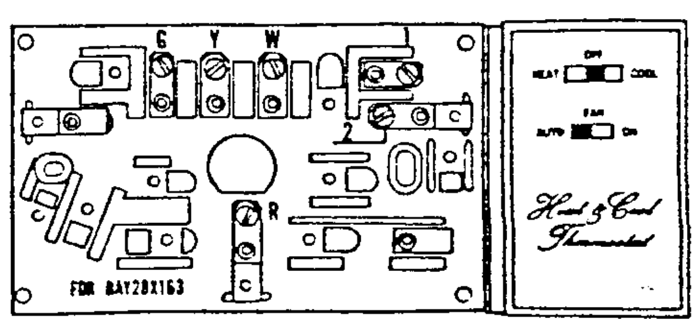
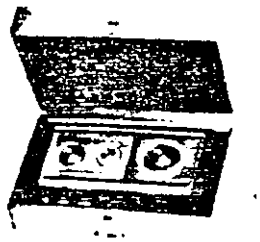



Figure 11

*W884B continued*

| ORDER NUMBER | APPLICATION | HUMIDITY CONTROLLER SWITCHING | RH RANGE | DIFFERENTIAL | INCLUDES |
|---|---|---|---|---|---|
| W884B1007 | Controls heating-cooling and humidification systems. | Spst; switch makes on RH decrease | 10 to 35 percent. | 2 to 3 percent RH. | T87F Thermostat, Q539 Switching Subbase, humidistat. |

## DSP1338 DISPLAY CASE



HOLDS THE W884 COMFORT CONTROL CENTER OR T8082 OR T882 CHRONOTHERM THERMOSTAT (NOT INCLUDED).

Used for display and sales demonstrations. Brown vinyl case. Black velvet interior. Approximate Dimensions: 10 x 6-1/4 x 3-1/4 in. [254 x 158.8 x 82.6 mm].

## DSP1592 DISPLAY CASE

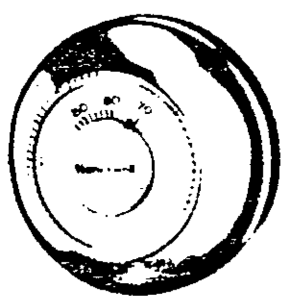
SPECIAL CARRYING CASE WITH SPACE FOR DISPLAY BOARD AND 2 THERMOSTATS.

Walnut grained display board has prepunched holes for mounting T8082, T8084, T882, T87, W884. Space for additional sales material. Case Color: Black. Approximate Dimensions: 17 x 11-3/4 x 4 in. [431.8 x 298.5 x 101.6 mm].

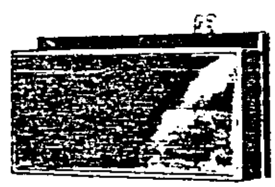
## LOW VOLTAGE THERMOSTATS MEETING DEPARTMENT OF DEFENSE SPECIFICATIONS

(Department of Defense [DoD] Manual 4270.1-M)

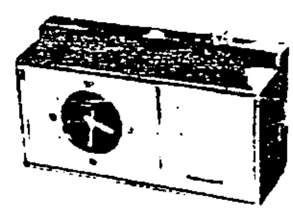
See SPECIFICATIONS and order table below for heating, cooling, and heating/cooling thermostats meeting DoD standards.



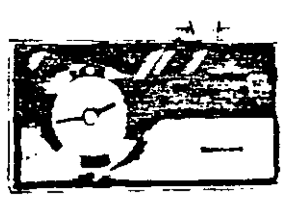
T87



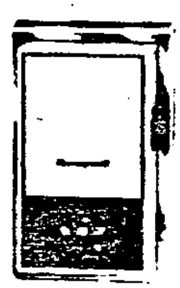
T872



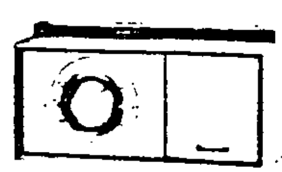
T882



T8082



T822
T5822



T8084

# thermostats

SPECIFICATIONS:

| MODEL | ELECTRICAL RATING | ANTICIPATOR HEATING | ANTICIPATOR COOLING | SWITCHING | DIMENSIONS |
|---|---|---|---|---|---|
| T87 | 1.5 amp at 30V ac. | Adj. 0.1 to 1.2 amp. | Fixed 0 to 1.5 amp, 24 to 30V ac. | Spdt | 3-1/4 in. [82.6 mm] dia., 1-1/2 in [38.1 mm] deep. |
| T822 | 1.5 amp at 30V ac. | Adj. 0.18 to 0.80 amp. | — | Spst | 4-3/4 in. [120.7 mm] high, 2-7/8 in. [73.0 mm] wide, 1-1/8 in [28.6 mm] deep. |
| TS822 | 0.1 amp at 750 mV | Fixed resistor. | — | | |
| T872 | Heating—1.2 amp at 30V ac at each stage. Cooling—1.5 amp at 30V dc. | Adj. 0.1 to 1.2 amp each stage. | Fixed 0 to 1.5 amp, 24 to 30V ac. | Spst | 3-9/16 in. [90.5 mm] high, 5-5/8 in. [142.9 mm] wide, 2-5/16 in. [58.7 mm] deep. |
| T882 | 1.5 amp at 30V ac. | Adj. 0.1 to 1.2 amp. | — | Spdt | 3-3/8 in. [85.7 mm] high, 6-1/16 in. [154.0 mm] wide, 2-1/8 in. [54.0 mm] deep. |
| T8082 | 1.5 amp at 30V ac. | Adj. 0.1 to 1.2 amp. | — | Spdt | 4-1/16 in. [103.2 mm] high, 6-23/32 in. [170.7 mm] wide, 2-1/4 in. [57.2 mm] deep. |
| T8084 | 1.5 amp at 30V ac. | Adj. 0.1 to 1.2 amp. | — | Spdt | 3-3/8 in. [85.7 mm] high, 6-1/16 in. [154.0 mm] wide, 2-1/8 in. [54.0 mm] deep. |

| ORDER NUMBER | APPLICATION | SET POINT RANGE | FEATURES | ADDITIONAL |
|---|---|---|---|---|
| T87F2816 | Heating only. | 38- 72 F [3-22 C] | Locking cover. No thermometer. | Includes wallplate and screws. |
| T87F2824 | Cooling only. | 78-112 F [26-44 C] | Locking cover. No thermometer. | |
| T822D1719 | Heating only. | 45- 75 F [7-24 C] | No thermometer. | For wall or vertical outlet box mounting. Two screws furnished for wall mounting. |
| TS822A1161 | Heating only, 750 mV applications. | 45- 75 F [7-24 C] | No thermometer. | |
| T872A1261 | 1-stage heating. 1-stage cooling. | Heating: 40-72 F [4-22 C] Cooling: 78-90 F [26-32 C] | Locking cover. No thermometer. | Separate levers for heating and cooling set point control. Set point lever ranges not adjustable. |
| T872C1400 | 2-stage heating. 1-stage cooling. | Heating: 40-72 F [4-22 C] Cooling: 78-90 F [26-32 C] | Locking cover. No thermometer. | |
| T882A1286 | Heating only. | 45-75 F [7-24 C] | No thermometer. Maximum 65 F [18 C] during setback period. | Includes 2- or 3-wire wallplate and screws, AT75A Clock Transformer. |
| T8082A1296 | Heating only. | 38-72 F [3-22 C] | Locking cover; lever locking screws. No thermometer. Maximum 65 F [18 C] during setback period. | With program advance button, 2- or 3- wire wallplate and screws. |
| T8084B1011 | Heating only. | 38-72 F [3-22 C] | Lever locking screws. No thermometer. | Provides temperature setback. |



Figure 13

JOHNSON CONTROLS

Johnson Controls, Inc.
Penn Division

2221 Camden Court
Oak Brook IL 60521

# Series T52 Low Voltage Multi-Stage Thermostats With Automatic Changeover

## Application

These low voltage thermostats control temperature by opening and closing circuits to heating and/or cooling equipment in response to room temperature changes. They are for applications where automatic or manual switchover of single or multiple heating and cooling stages is required.

Types T52AAE, T52AGE and T52BGE meet DOD Specifications.

## Features

—One or two-stage operation.

—Automatic or manual switchover from heating to cooling.

—Individual heating and cooling thermostats.

—Roll type temperature dials with locks.

—Models with DOD Specification have permanent dial limit stops. Maximum heating set point is 75F (24C), minimum cooling set point is 75F (24C).

—Mercury switches provide silent, dust free contacts.

—Bimetal thermometer is standard.

—Locking metal cover.

—Adjustable heating anticipation, fixed cooling anticipation.

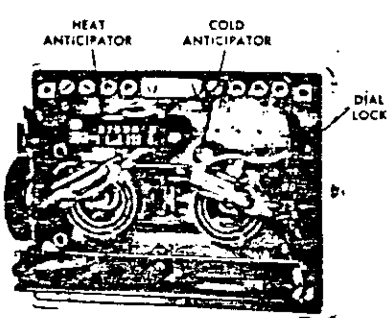



**Fig. 2—Interior view of Type Number T52AEA.**

## General Description

The Series T52 thermostat is desirable where automatic operation of air conditioning and heating equipment is required.

The system automatically switches (or may be manually selected) to heating or cooling, as needed; however, a mechanical interlock prevents heating and cooling from being connected at the same time. These thermostats are available with one or two-stage operation on heating and cooling systems. Sequential contacting of two-stage units is provided through common actuation.

Each model has two separate, hermetically sealed, mercury switch thermostats...one for heating and one for cooling. Individual set point dials allow selection of the desired heating and cooling temperatures.

Each thermostat has set point dial locks and a locking cover to prevent unauthorized adjustments. After the desired settings are made, each dial may be held in place by a screwdriver adjusted clamp located under the cover. See Fig. 2. The cover is attached to the sub-base by two Allen head screws to discourage removal by unauthorized personnel.

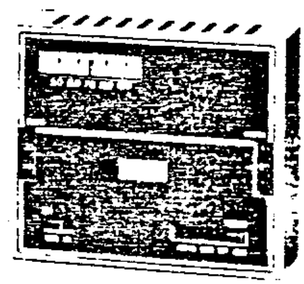


**Fig. 1—Exterior of Series T52 with Fan and System switches.**

## Optional Constructions

**Thermometer:** Standard on all types. Thermostats are available less thermometer, on quantity orders.

**Adapter Plate Kit:** Kit No. PLT35A-600 is available when a vertical thermostat is replaced or when a Series T52 thermostat is mounted on a vertical outlet box. The adapter plate is 4⁹⁄₁₆" x 4⁷⁄₈", beige plastic.

## Repairs and Replacement

Field repairs must not be made. Replacement thermostats may be obtained from the nearest Penn-Baso Wholesaler. When ordering a replacement thermostat, specify Product Number and Serial Number as shown on cover label of the thermostat.

## Ordering Information

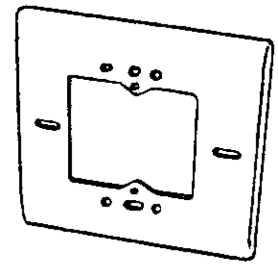
To order, specify complete Product Number. If thermostats with specifications other than standard are required, specify Type Number and specifications.

Figure 14

## Specifications

| | | |
|---|---|---|
| Type Number | T52AAE* | One-Stage Heating, One-Stage Cooling No Switches |
| | T52AEA | One-Stage Heating, One-Stage Cooling, System—"Auto-Heat-Off-Cool," Fan—"Auto-On" |
| | T52AQE* | One-Stage Heating, One-Stage Cooling, System—"Heat-Off-Cool", Fan—"Auto-On" |
| | T52BEA | One-Stage Heating, Two-Stages Cooling, System—"Auto-Heat-Off-Cool," Fan—"Auto-On" |
| | T52BGE* | One-Stage Heating, Two-Stages Cooling, System—"Heat-Off-Cool", Fan—"Auto-On" |
| | T52CEA | Two-Stages Heating, One-Stage Cooling, System—"Auto-Heat-Off-Cool," Fan—"Auto-On" |
| | T52DAA | Two-Stages Heating, Two-Stages Cooling, No Switches, System On Auto, Fan Can Be Wired for Auto Operation in Cooling Mode |
| | T52DEA | Two-Stages Heating, Two-Stages Cooling, System—"Auto-Heat-Off-Cool," Fan—"Auto-On" |
| Anticipation | Heating | Adjustable 0.3 to 0.8 Amp |
| | Cooling | Fixed |
| Differential (Nominal Thermal) | First Stage Heating | 1.5F (0.8C) |
| | Second Stage Heating | 2F (1.1C) |
| | First Stage Cooling | 2F (1.1C) |
| | Second Stage Cooling | 2F (1.1C) |
| | | Minimum Interlock Between First Stage Heating On and First Stage Cooling On, 4F (2.2C) |
| | | Setting Between First Stage Heating On to Second Stage Heating On, 2F (1.1C) |
| | | Setting Between First Stage Cooling On to Second Stage Cooling On, 2F (1.1C) |
| Electrical Contact Unit | | Hermetically Sealed SPST Mercury Switches |
| Electrical Contact Rating | | 0.8 Amp. Maximum at 24 V. A.C. |
| Material | Cover | Cold Rolled Steel with "Tawny Silver" Finish |
| | Thermostat Base, Wiring Sub-Base | Gray Plastic |
| Packaging | | Individually Packed In Reshippable Corrugated Carton |
| Range | Standard Models | Heating 50 to 85F (10 to 30C) |
| | | Cooling 55 to 90F (13 to 32C) |
| | Models with DOD Specifications | Heating 50 to 75F (10 to 24C) |
| | | Cooling 75 to 90F (24 to 32C) |
| Shipping Weight | Individual Pack | 1 3 lbs (0.6 kg) |
| | Overpack of 20 | 28 6 lbs. (13 kg) |
| Wiring | | All Wiring Is Low Voltage Class 2 to Sub-Base |

*Designed to meet DOD Specification 4270.23; Army Guide Specification OCE GSH 15 16a Navy Guide Specification FAC GSH 15 16a and Air Force Manual AFM 85-25 Sec 15 16a Guide Specifications for Military Family Housing, Air Conditioning, mechanical, Operating Controls: "Cooling and Heating-Cooling thermostats." Range: Heating, 50 to 75F; cooling 75 to 90F. Less thermometer [illegible]



Adapter Plate
PLT35A-600

Figure 15

JOHNSON CONTROLS

Johnson Controls, Inc.
Penn Division

2221 Camden Court
Oak Brook IL 60521

# Series T26 Line Voltage Thermostat Heating, Cooling, Combination Heating and Cooling Standard Duty and Heavy Duty

## APPLICATION

These line voltage thermostats control heating, cooling, or year 'round air conditioning units in commercial, industrial or residential installations. Typical uses are for unit heaters, fan coils, blast coils, refrigerated storage rooms, electric heat, duct furnaces, greenhouses, etc. Models are available with SPST or SPDT contact action and for standard duty (nominal 1/4 hp; 10 amps. non-inductive) or heavy duty (nominal 1 hp; 22 amps. non-inductive) applications. These thermostats are also suitable for low voltage applications.

Where critical or high value products are to be maintained at a specific temperature, a single thermostat should not be applied to perform as both an operating and a limit control. In these applications a separate limit control with alarm contacts should be wired to indicate when the limit control operates.

For line voltage thermostats with integral selector switches refer to Series T22, Bulletin 3233.

For low voltage thermostats refer to Series T51 and Y51 Bulletin 3144.

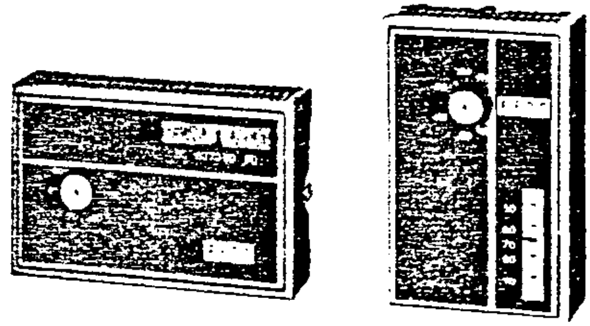


Fig. 1 — Series T26 thermostat with horizontal faceplate (left) or vertical faceplate (right).

## FEATURES

— Energy conservation models available featuring fixed limited ranges.

— Field adaptable to vertical/horizontal mounting and for knob, key or concealed adjustment.

— Knob, key or concealed set point adjuster.

— Low and high limit dial stops — concealed, adjustable throughout set point range. Can be set for locked dial. See Fig. 2.

— Locking cover with Allen-head screws is standard.

— Close differential without need for anticipator.

— Internal dual Celsius and Fahrenheit scale is standard.

— Enclosed Pennswitch contact unit — dependable, dust proof and field proven.

— Separable mounting plate allows easy mounting and wiring without removing thermostat cover.

— Switch mechanism and wiring terminals (#8 screws) go into switch box for safety and isolation of load from sensing element.

— Matching humidistat (Series W43A) is available, see Bulletin 3391.

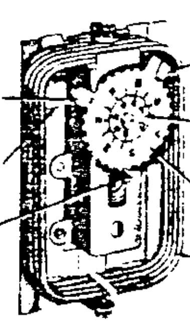



Fig. 2 — Interior of Series T26. Note how element is wrapped around inside of thermostat for maximum sensitivity. Integral adjustable high and low limit stops.

## GENERAL DESCRIPTION

These thermostats are extremely versatile. Using different field-installable faceplates, combinations of (1) verticle/horizontal mounting, (2) knob, key or concealed adjustment and (3) with or without thermometer indication are possible. These thermostats have metal locking covers with Allen-head screws to discourage unauthorized tampering. The standard models are supplied with a faceplate installed for verticle mounting with knob adjustment and thermometer. A field installable faceplate for horizontal mounting is also included on wholesaler models. See Figs. 1 and 6. Standard models are SPDT for heating, cooling or heating and cooling applications.

Standard models can be changed in the field as follows:

1. To convert to key adjustment, remove the screw from center of knob and the knob becomes the key.

2. To convert to other configurations, for example concealed adjustment, select the faceplate kit that meets the desired requirements from the "Faceplate Selection Table" on Page 3.

The cover and faceplate design makes the thermostats adaptable to any decor. The thermostats have a sturdy

Figure 16

steel cover with "tawny silver" finish. The faceplate is dark brown and light brown with aluminum numbers and graduation marks. The internal dial on these thermostats has a dual Fahrenheit-Celsius scale, see Fig. 2. When a faceplate with Celsius thermometer and set point scale is used the thermostat is totally Celsius.

The liquid charged sensing element is formed to achieve maximum sensitivity to surrounding air temperature changes (see Fig. 2). Coupled with a highly efficient diaphragm and leverage mechanism, the element operates a totally enclosed Pennswitch contact unit for close differential and dependable switching action without the use of "heat or cool" anticipators.

Elimination of anticipators increases versatility of these thermostats, which may be used on heating and/or cooling over a wide range of current loads, either on 24 V., 120 V. or 240 V. systems.

## TYPE NUMBER SELECTION

| Type Number | Function | Typical Application |
|---|---|---|
| **HEATING** | | |
| T26A | SPST heating | Fig. 7 |
| T26B | SPST heavy duty heating | Fig. 7 |
| **COOLING** | | |
| T26J | SPST cooling | Fig. 8 |
| **HEATING, COOLING OR HEATING AND COOLING** | | |
| T26S | SPDT heating and cooling | Figs. 9 thru 13 |
| T26T | SPDT heavy duty heating and cooling | Figs. 9 thru 13 |

## SPECIFICATIONS

| Thermostat Range °F. (°C.) | Thermometer Range °F. (°C.) |
|---|---|
| 40 to 90 (5 to 30) | 50 to 90 (10 to 30) |

**Mechanical Differential:** Approximately 0.7° F. (.4° C.).

**Operating Differential:** The operating temperature differential of any self-contained thermostat depends on the current flowing through the thermostat (amperage load), the velocity of air over the thermostat, the rate of temperature change to which the thermostat is subjected and whether the thermostat is operating heating or cooling equipment.

Graphs (Figs. 3 and 4) show the operating temperature differentials of these thermostats under various load conditions. These curves are based on tests made in a NEMA standard test box according to NEMA standard

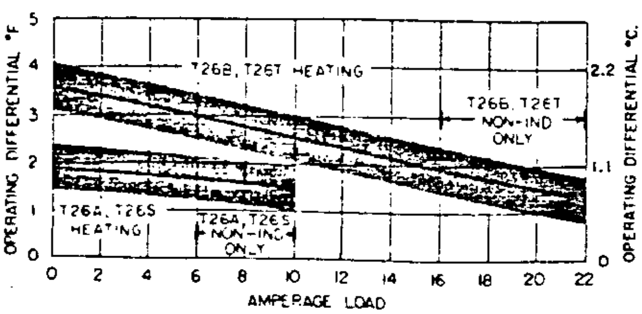



Fig. 3 — Operating differential for Series T26A and heating side of Series T26S (lower graph line). Upper graph line illustrates differential for T26B and heating side of T26T.

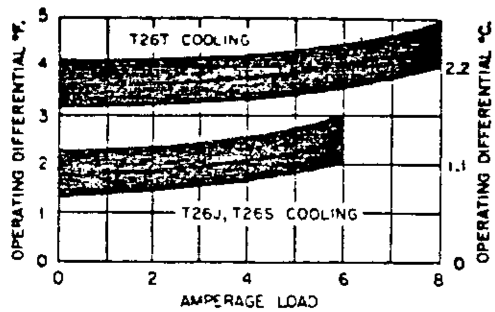



Fig. 4 — Operating differential for Series T26J and cooling side of Series T26S (lower graph line). Upper graph line illustrates differential for cooling side of Series T26T.

The heavy line in each of the above figures is the nominal operating temperature differential. Production thermostats may vary from the norm as indicated by the shaded areas.

DC3-1959. The air velocity was 25 feet per minute (.127 m/sec.) and the rate of temperature change was 6° F. (3.3° C.) per hour. For air velocities greater than 25 feet per minute and/or for rates of temperature change less than 6° F. per hour, the operating differentials will be less than shown in Figures 3 and 4.

**Base:** .050" (1.27 mm) cold rolled steel. Baked on "tawny silver" finish.

**Cover:** .025" (.64 mm) cold rolled steel. Baked on "tawny silver" finish. Faceplate is dark brown and light brown with aluminum letters and markings.

**Mounting:** Separable mounting plate, see Figs. 5 and 6.

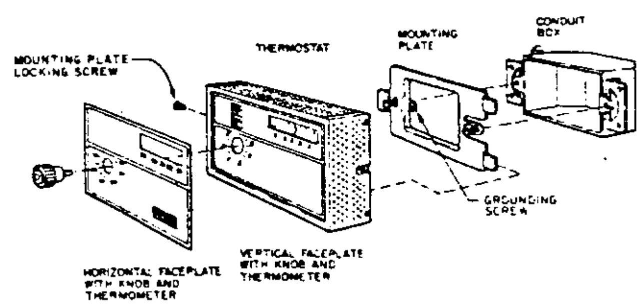



Fig. 5 — Line drawing illustrating method of mounting a vertical thermostat to a horizontal outlet box and installing a horizontal faceplate.

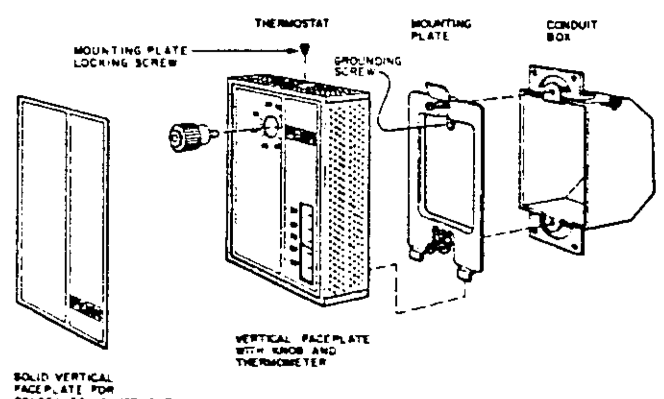



Fig. 6 — Line drawing illustrating method of mounting a vertical thermostat to outlet box. Also shown is a solid vertical faceplate for concealed adjustment when desired.

Discussion - 3.4 Continued

Representatives of both the General Electric Company and Honeywell indicated that their "energy conserving" thermostats meeting the requirements of ASHRAE 90-75 were sold directly to agencies of the Federal Government and doubted if many (or any) were sold to manufacturers for use with residential heating/cooling equipment.

Thermostats (and other similar controls) produced by Barber Coleman and Johnson Controls usually are installed in commercial and institutional buildings requiring extensive control systems.

Even though 58% of the respondents to the survey indicated that they checked for compliance either during a review of the plans or during construction it is doubtful if more than a handful of building inspectors in the State have ever seen an "energy conserving" thermostat.

This report recommends that thermostats required by Section 503.7(a) be applied only to non-residential buildings for the following reasons:

1. They do not appear to be available for residential size air conditioning or heating equipment.

2. In a private residence, the thermostat can easily be altered or replaced by the owner.

3. They will add between $60 and 80 dollars to the cost of a new residence.

This report also recommends that building officials, architects and engineers be made aware of the availability of units of this type so that they will be specified for commercial and institutional construction.

Discussion

3.5

Section 503.5 of the FMEE Code states:

> "The air transport factor for each all-air HVAC system shall not be less than 8.0. The factor shall be based on design system air flow for constant volume systems. The factor for variable air volume systems may be based on average conditions of operation. Energy for transfer of air through heat recovery devices shall not be included in determining the factor; however, such energy shall be included in the evaluation of the effectiveness of the heat recovery system."

$$\text{Air Transport Factor} = \frac{\text{Space Sensible Heat Removal*}}{\text{Supply + Return Fan(s) Power Input*}}$$

*Expressed in Btu/h

The response to the survey questions pertaining to this requirement of the Code was:

1. 50% of those responding indicated that they did not check for compliance.

2. 67% of those responding indicated either that this requirement be deleted from the Code or that they had no opinion regarding its retention.

The "air transport factor" as defined by ASHRAE 90-75 and the FMEE Code is the ratio between the space sensible heat removal divided by the energy required to circulate the air through the space or building. In order for the formula to be used it must be refined to read:

$$\text{ATF} = \frac{\text{Space Sensible Heat Removal (Load) BTU/Hr}}{\left(\begin{array}{c}\text{Current drawn by}\\ \text{supply and return}\\ \text{air fans - Amps)}\end{array} \times \begin{array}{c}\text{(Voltage}\\ \text{of}\\ \text{motors)}\end{array} \times 3.41\ \text{BTU/Watt}\right)}$$

The heat gain of a building in the summertime - which must be removed in order to maintain a comfortable environment - consists of:

A. The sensible heat gain which includes heat entering the conditioned space by conduction thru walls, roofs (ceilings) and floors, the solar heat gain thru windows, the heat given off by people, lights and equipment, and the energy required to cool the air which infiltrates into the building thru cracks around windows and doors or is purposely brought into the building for ventilation purposes.

Discussion - 3.5 Continued

B. The latent heat gain which is the energy required to remove the moisture generated by people (perspiration) and equipment (usually from cooking) and to reduce the moisture content of the outside air which enters the building.

In designing a cooling system for a building a sensible and latent load calculation is made by the architect or engineer and the result of this calculation is used in the selection of equipment.

Most counties and municipalities in Florida do not require design drawings to be submitted for the heating systems of single family residences when the general contractor applies for the building permit or when the heating/air conditioning contractor applies for his/her permit. In addition, heat load calculations are not required for any building complying with the Code using the methodology of Section 5 "Building Design by Component Performance Approach."

It is therefore virtually impossible for building officials, even if they had the expertise, to correctly perform the "air transport factor" calculation in order to check for compliance.

The recommendation is therefore to change the first sentence of paragraph 505.3

From: "The air transport factor for each all air HVAC system shall not be less than 8.0."

To : "The air transport factor for each all air HVAC system should not be less than 8.0."

In so doing, it becomes a design recommendation - not a compliance requirement.

Discussion

3.6

Section 502.4 (b) and (c) of the FMEE Code states:

> (b) All exterior doors and windows shall be designed to limit air leakage into or from the building envelope. Manufactured doors and windows shall have air infiltration rates not exceeding those shown in Table 5-3. Site constructed doors and windows shall be sealed in accordance with Section 502.4(c).
>
> (c) Exterior joints around windows and door frames; openings between walls and foundations, between walls and roof/ceilings and between wall panels; openings at penetrations of utility services through walls, floors and roofs; and all other such openings in the building envelope shall be caulked, gasketed, weatherstripped or otherwise sealed in an approved manner.

The response to the survey questions pertaining to this requirement of the Code was:

1. 25% of those responding indicated that they did not check for compliance.

2. 37½% of those responding indicated either that this requirement be deleted from the Code or that they had no opinion regarding its retention.

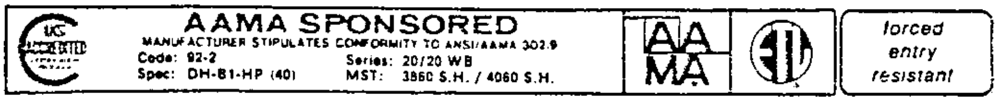
Almost all exterior doors used in residential construction are essentially "site" constructed except for sliding glass doors. A "site" constructed door is one where the contractor purchases a door which is not pre-hung and constructs the surrounding frame on the construction site. This type of door is not required to conform to the required maximum allowable air infiltration rates listed in Table 5-3 of the FMEE Code.

Sliding glass and "pre-hung" swinging exterior doors are required to conform to the air infiltration rates.

This investigation determined that pre-hung swinging and sliding glass doors for sale by building supply chains such as Scotties, West and Lowe's (and other local building supply stores) had no markings indicating compliance with the air infiltration rates of the FMEE Code or any other national association such as ANSI (American National Standards Institute - formerly the American Standards Association - ASA).

Discussion - 3.6 Continued

This investigation also determined that aluminum windows for sale by some local building supply chains (West and Scotties) have decals indicating conformity to ANSI/AAMA 302.9 (Architectural Aluminum Manufacturing Association).




DECAL FROM ALUMINUM WINDOW MANUFACTURED BY CROFT METALS, INC.

Figure 18

The minimum air infiltration rates called for by ASHRAE and the FMEE Code are identical to those required by ANSI/AAMA 302.9 for aluminum windows and ANSI/AAMA 402.9 for aluminum sliding glass doors. However, if building inspectors were unfamiliar with the particular specifications, they would have no way of judging conformity.

Reputable manufacturers of wood windows do test their products and those who advertise in Sweet's Catalog indicate air infiltration rates smaller than required by the Code. However, their products are not marked nor do they have an industry standard which they can refer to.

All doors and windows must be inserted into the building wall on the "site." The joints around doors and windows are required to be suitably sealed in accordance with "accepted practice." This requirement, although vague and subject to interpretation by every building official, can be inspected for during construction.

The recommendation is therefore to allow this Section to remain but to attempt to get 100% compliance by Education of Building officials and manufacturers. For additional discussion, see Section 4.1.

Discussion

3.7

Converting electric energy derived from the combustion of fossil fuels directly into heat to heat a structure is highly inefficient compared with other methods currently available.

In Florida, residential and small commercial buildings are the types of structures which are usually totally heated, using electric resistance heating elements. While this type of heating is most usually associated with buildings located in the warmer counties (South Florida) it is by no means limited to that area.

The major reason for the utilization of electric resistance heating is the initial cost. It is the least expensive type of heating system to install - thereby decreasing the construction cost of the structure.

When one watt hour of electric energy is converted into heat energy the resulting amount of heat derived is 3.41 BTU (no more - no less). With the use of a "heat pump", (a mechanical refrigeration system which can both heat and cool) one watt hour of electric energy input can produce up to 13 BTU of heat depending upon the temperature of the condensing medium. The "condensing medium" is either the outside air or water from a lake, well, city water main, etc. The warmer the condensing medium, the more heat which can be extracted from it.

As the outside temperature decreases the amount of heat a building requires to maintain a comfortable environment increases while at the same time the heat output of the heat pump (if the condensing medium is air) decreases. At this point, supplemental heating is necessary and that heat invariably comes from electric resistance heating elements installed in the furnace or in the ductwork.

When these heating elements are energized the entire structure is being heated using an inefficient energy source.

Calculations were made for what was believed to be an average concrete block house of 1800 $ft^2$ which was insulated in accordance with the prescriptive amounts of insulation recommended in Sections 3.1, 3.2, and 3.3. One calculation was done assuming the building was located in Jacksonville and the other in Miami.

Information received from one manufacturer on the price difference between a heat pump and a straight cooling unit - both having reasonably equivalent cooling efficiencies - is as follows:

Discussion - 3.7 Continued

| Size of Unit In Tons | Price Difference |
|---|---|
| 2 | $287 |
| 2½ | $437 |
| 3 | $534 |
| 3½ | $550 |
| 4 | $637 |

The price of a heat pump is naturally greater than a straight cooling unit. These price differences include the more expensive thermostat required for a heat pump and a 10% mark-up for the contractor. The state sales tax of 4% is not included.

Based on the configuration of the building and its components, the building was estimated to require a 3-ton cooling unit.

Using data from the 1981 ASHRAE Handbook of Fundamentals, a reasonably high efficiency heat pump - and the following:

A. Calculated heat loss of the building [equal to 35,300 btu/hr] assuming 75°F inside and 30°F outside temperatures.

B. Average 12 year equipment life.

C. 15% interest rate.

D. 7 cents/kwh cost of power.

Our calculations indicated that - for heating only:

A. The annual cost for electric resistance strip heating in Jacksonville is approximately $483 greater than if a heat pump was utilized.

B. The annual cost for electric resistance strip heating in Miami is approximately $70 greater than if a heat pump was utilized.

C. The additional amount of energy consumed by the use of strip heating in Jacksonville was 8,000 kwh/yr and 1,268 kwh/yr in Miami.

The recommendations is therefore for the FMEE Code to prohibit the use of electric resistance heating elements in all-air HVAC systems including supplementary duct or furnace heaters used in conjunction with heat pumps which exceed 25% of the units rated heating capacity at 47°F, but to allow built-in individual room electric heating units which have their own thermostats.

Discussion

3.8

Section 504.2(a) - 2 of the FMEE Code states in part:

> "All gas and oil fired automatic storage water heaters shall have a recovery efficiency ($E_r$) not less than 70 percent..."

The 1980 House Bill 1506 requires that gas fired water heaters have a recovery efficiency of 75 percent. ASHRAE 90-75 (Section 7.3.1.2) also requires that all gas and oil fired automatic storage heaters have a recovery efficiency of 75 percent effective January 1, 1977.

Since the investigation revealed that gas fired heaters meeting the 75% efficiency requirement were available for sale (and that few oil fired hot water heaters are sold in Florida) the recommendation is to change the efficiency requirement of the FMEE Code from 70 percent to 75 percent.

For additional discussion - refer to Section 2.3 of this report.

## Discussion

4.1

A mail survey was conducted which requested randomly selected building officials to answer a few simple questions regarding three requirements of the FMEE Code.

To encourage replies, a self-addressed stamped envelope was enclosed with each questionnaire. The response ratios were as follows:

A. % of questionnaires returned by the postal service for inadequate addresses: 1.5%

B. % of delivered questionnaires replying: 35 %

The questionnaire and a graphic representation of the responses will be found on the following pages.

The purpose of the survey of building officials was to ascertain if compliance to some of the more technical requirements of the FMEE Code were being enforced.

The results of the responses are suspect. The total response to the second question re the "air transport factor" should have been "we do not check for compliance." Yet replies indicated otherwise. The response to the third question re "thermostats" should also overwhelming have been "we do not check for compliance." Yet here again, the majority of replies indicated otherwise.

Comments revealed the following:

A. Some inspection departments suffer from a lack of manpower.

B. Some inspection departments do not have "mechanical inspectors."

C. Some inspection departments suffer from a lack of knowledgeable personnel.

D. Most inspection departments really do not understand the technical requirements of the FMEE Code or even how to check for compliance.

The results of the survey generate the following conclusions:

A. That regardless of the opinions expressed by architects, engineers and some developers at meetings of the Florida Homebuilders' Energy Committee, more prescriptive requirements should be enacted into law

B. Change those requirements in the Code which cannot be enforced into design recommendations.

C. Establish a program which will instruct building officials and building inspectors on the proper procedures to use in checking the important features of the Code in the field.

D. Enlist the assistance of building material suppliers to encourage manufacturers of building components to apply decals to their products indicating compliance with ASHRAE 90-75, where applicable.

## FLORIDA MODEL ENERGY EFFICIENCY CODE SURVEY

Section 502.4 addresses the criteria of "Air Leakage for All Buildings." Table 5-3 lists "Allowable Air Infiltration Rates" for Windows and doors.

With reference to this particular section, please answer the following questions.

1. We check the Plans and Specifications for compliance. . . . . . . . . ☐
2. We check for compliance during construction. . . . . . . . . . . . . . . ☐ *
3. We DO NOT check for compliance. . . . . . . . . . . . . . . . . . . . . . ☐ **

   * We check for compliance by: (How do you do it?)

   ** We do not check for compliance because:

|  | YES | NO |
|---|---|---|
| 4. In your opinion, should this requirement, as presently written, be deleted from the code:. . . . . . . . . . . . . . . . . . . | ☐ | ☐ |

Section 503.5 addresses the energy requirements for Air Delivery and states that the "Air Transport Factor" shall not be less than 8.0 for each All-Air H.V.A.C. System.

With reference to this requirement, please answer the following questions:

1. We check the Plans and Specifications for compliance. . . . . . . . . ☐
2. We check for compliance during construction. . . . . . . . . . . . . . . ☐ *
3. We DO NOT check for compliance. . . . . . . . . . . . . . . . . . . . . . ☐ **

   * We check for compliance by:

   ** We do not check for compliance because:

|  | YES | NO |
|---|---|---|
| 4. In your opinion, should this requirement, as presently written, be deleted from the code? . . . . . . . . . . . . . . . . . | ☐ | ☐ |

Figure 19

Section 503.7 prescribes design and operating criteria for temperature controls (thermostats).

With reference to the requirements listed in Sections 503.7 (a) and 503.7 (c), please answer the following questions:

1. We check the Plans and Specifications for compliance. . . . . . . . . ☐

2. We check for compliance during construction. . . . . . . . . . . . . . . ☐ *

3. We DO NOT check for compliance . . . . . . . . . . . . . . . . . . . . ☐ **

* We check for compliance by:

* We do not check for compliance because:

| | YES | NO |
|---|---|---|
| 4. In your opinion, should this requirement, as presently written be deleted from the code?. . . . . . . . . . . . . . . . | ☐ | ☐ |

Figure 20

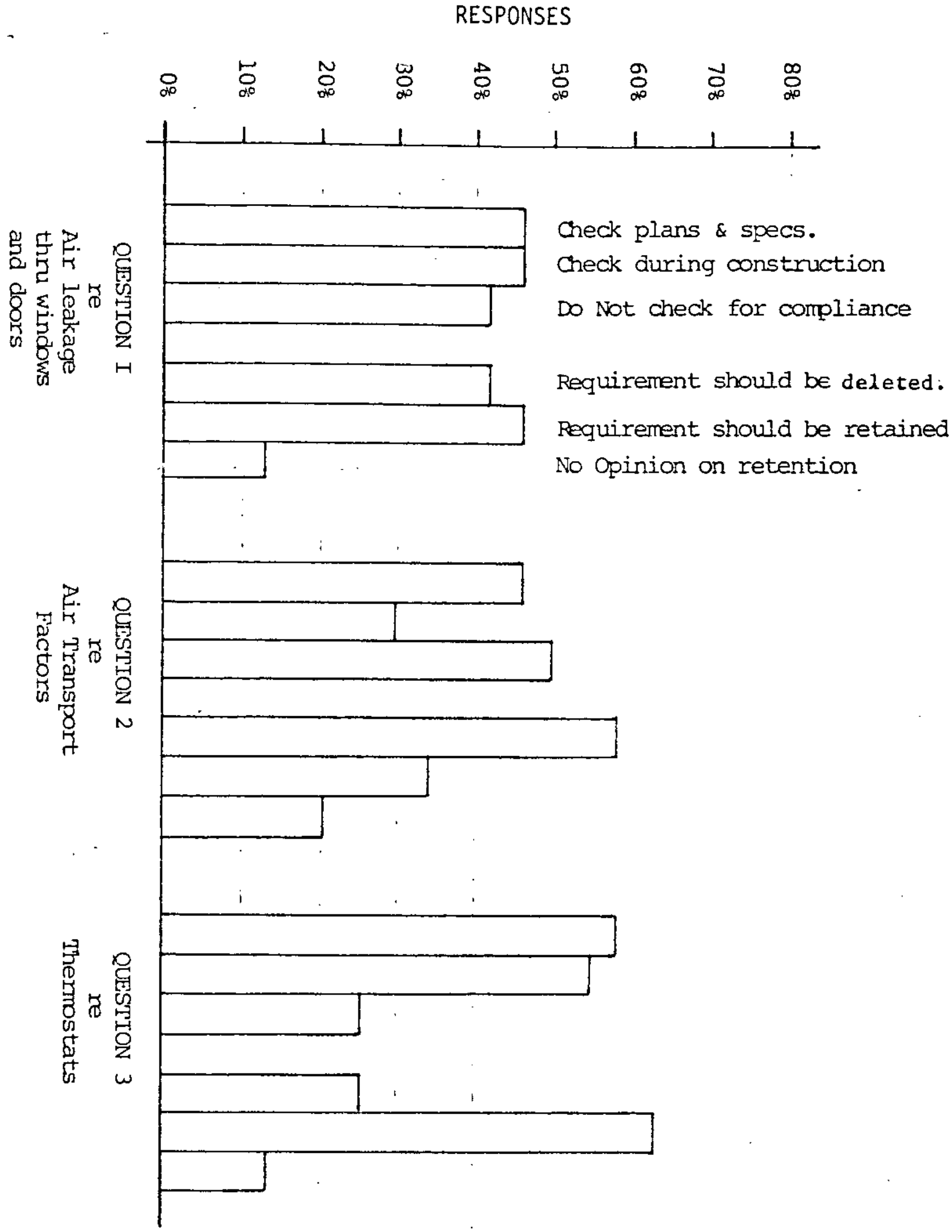



Figure 21

Graphic Representation of Replies
to Questions about FMEE Code by Building Officials