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Improved Heating Operations at an L-Shaped Barracks: Assessment and Specifications

by
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Data from earlier USACERL research that applied energy conservation retrofits to standard Army building types indicated that the retrofits were undermined by less than optimal building operations. This report documents follow-up work to measure the effect of improved building operations on one of the retrofit buildings, an L-shaped barracks. The results indicate that fuel savings from improved operations nearly equalled fuel savings resulting from the initial retrofit. Specific steps for improving operations are outlined, and it is recommended that the improvements implemented for this building be applied to other ,imilarly constructed and operated buildings.

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FOREWORD

This work was performed for the U.S. Army Engineering and Housing Support Center (USAEHSC), under Facilities Engineering Application Program (FEAP) "Energy Conservation Retrofits for Standard Designs." B. Wasserman, CEHSC-FU, was the technical monitor. Operations improvement was funded in part by the U.S. Army Forces Command (FORSCOM) under reimbursable project Intra-Army Order FC-176-87, "Assessment of Energy Savings through Improved Operations of Heating Equipment." Naresh Kapoor, FCEN-RDF, was the FORSCOM Project Monitor.

The research was performed and coordinated by the Energy and Utility Systems Division (FE) of the Infrastructure Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). Some of this effort was done under contract by Arthur D. Little, Inc., where Richard Caron was principal investigator. Dr. David M. Joncich is Chief, CECER-FE, and Dr. Michael J. O'Connor is Chief, CECER-FL.

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COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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2 ORIGINAL BUILDING CONFIGURATION

Building Layout and Use

Building 811 is an L-shaped (Type 64) bachelor enlisted quarters constructed in 1956. Figures 1 and 2 show an original floor plan and exterior view for the barracks. It has a three-story barracks wing plus an adjoining single-story dining facility. The total floor area of about 38,000 sq ft* consists of about 11,000 sq ft for each of the three barracks floors and about 5,000 sq ft for the single story wing. The three-story barracks wing is oriented north and south and the single-story kitchen/mess hall wing is oriented east and west at the south end of the barracks wing.

The barracks wing has double- and single-occupancy sleeping quarters, ground level offices, lounging rooms, and laundry and bathing facilities. Originally an open-bay sleeping design with capacity for 178 residents, the barracks wing was converted to individual rooms in 1978. This wing is built above a combination of basement and crawl space. The basement is used for an equipment storage and office area. The kitchen/mess hall wing is currently being used for a first-aid station, classrooms, and offices. The kitchen equipment has been removed (with the exception of a walk-in refrigerator) and the plumbing service has been capped. The south wing is built over a partial basement which houses the mechanical room.

Building Construction

The building was originally constructed of 8-in. concrete block exterior walls, 6-in. concrete ground floor, and a roof composed of 1/2 in. stone, 2 in. rigid insulation, 2 in. concrete, an air space, and acoustic tile. The building had numerous single pane windows. Energy retrofits in 1985 resulted in:

- the blocking of 50 percent of the window area
- the replacement of existing window units with double-glazed, double-hung, thermal-sash window units
- the addition of exterior wall insulation consisting of 2 in. of rigid polystyrene and a 3/8-in. polymer-modified portland cement stucco finish
- the replacement of two existing electric fixed-setpoint heating water controllers with pneumatic outdoor reset controllers
- and the blanking of the outside air intake to one of the south wing's air handler units.

Heating

Heat is provided to the barracks wing through hot water fin-tube radiation. (The south wing also uses a steam unit heater.) The building is zoned for three hydronic heating loops: the east side barracks wing (zone 1), the west side barracks wing (zone 2), and the south wing mess hall area, now first-aid/classroom (zone 3).

The hot water heating pipes form a two-pipe reverse return system. The pipes for the barracks wing run through the crawl space and up several three-story risers on each side of the building. These pipes branch off at the risers on each floor to supply perimeter hot water to the fin-tube radiators running for a series of approximately five dormitory rooms or one stairwell. A two-pipe reverse return system is inherently self-balancing; no balancing valves were found on the hot water pipes. However, there were

*Metric conversions are listed on p 28.

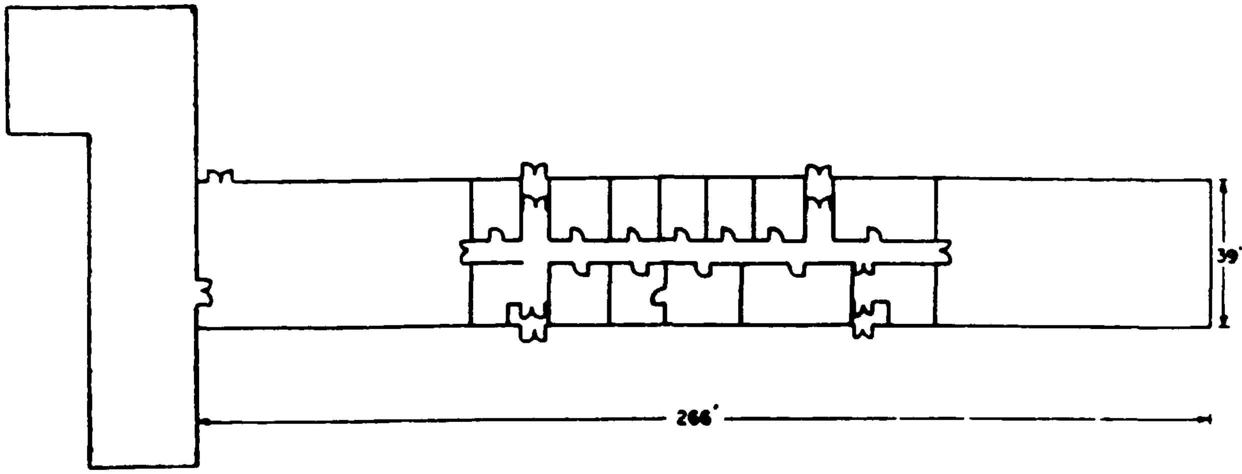


Figure 1. Original Floor Plan, L-Shaped Barracks.

Figure 2. Exterior View, Building 811.

a few shut-off valves. The dampers on the radiator cabinets originally had pull chains to close off the louvered openings for decreased heat exchange, but no operable dampers were found.

The circulation pumps for the three heating zones are controlled by an outside air sensor that turns the pumps off when the outside temperature is above a set point. The south zone also has an interior thermostat that overrides pump circulation for zone 3 below the pump cut off temperature. The indoor thermostats for the barracks zones (zones 1 and 2) which were indicated on the original building plans are no longer installed.

As a result of the 1985 retrofit, the circulating temperature of the hot water to zones 1 and 2 was reset based on outside temperature. The supply temperature ranges linearly from a minimum setting (during warmer weather) to a maximum setting (during colder weather.) The supply temperature of the hot water to the south zone was not reset.

Boilers

The hydronic heating system is serviced with one of two Kewanee gas-fired steam boilers with nameplate input ratings of 3.12 MBtu/hr. The operating boiler is currently firing at about 1.8 MBtu/hr, presumably from intentional derating. One boiler is used strictly for stand-by and brought on line as needed. The working boiler maintains a steam pressure currently set at 9 to 13 psi. Steam was provided to three hot water converters, a 645-gal domestic hot water storage tank, and a unit heater in the south wing. Steam pressure was maintained continuously during the heating season even when heating circulation pumps were off.

Cooling

Cooling is provided by chilled water, supplied from a central plant, and pumped to fan coil units in the rooms. Fans can be controlled individually. The occupants and the heating shop have observed that cooling in the summertime is insufficient. There is no in-building control to limit the amount of cooling because there is no excess capacity.

Ventilation

Four air handlers provided ventilation in the original building design. Two serviced the old kitchen area (one blanked off), one serviced the old dining area, and one serviced the hallways of the barracks wing. At the time of the last inspection, all forced ventilation had been disabled.

Domestic Hot Water

Domestic Hot Water (DHW) was provided by a direct-fired gas unit and by a steam heat exchanger serviced by the boiler. The boiler provided the primary heating, and the direct-fired unit cycled if the boiler was unable to meet the demand. DHW was maintained near 180 °F.

3 OPERATIONAL FINDINGS

General

The building was substantially overheated, a condition caused by a combination of inadequate equipment, improperly set equipment, and inappropriate actions of occupants and operators (e.g.,leaving windows open in cold weather). The part-load efficiencies of the space heating and DHW heating systems were low due to various standby losses and control strategies.

Specific

The temperature control of the building was inadequate for three major reasons:

1. The steam valves on the heating hot water converters were too large. The resultant control was on/off rather than modulating.

2. The existing hot water controllers were not set for existing conditions and were also difficult to set and maintain.

3. Some control wiring was broken.

The boiler was controlled to maintain steam pressure regardless of a need for heat from mid-September through mid-May. The heat developed in the boiler was vented through the flue on the off-cycle. These factors caused significant standby losses in an area having a lengthy transition between seasons. Other problems with the heating equipment included a leak in the boiler, a need for boiler tune up and repair, a failed steam trap, and excessive vibrations in a circulating pump.

The DHW service posed both an energy and comfort concern. The plumbing for the DHW was valved so that most of the need was serviced by the steam boiler rather than the more efficient direct fired gas water heater. Further, the direct-fired water heater was underfiring and could not meet the DHW need alone. The shower heads were large or nonexistent, causing a heavier than needed DHW demand. Because there were no mixing valves, a scalding occurred if the toilet was flushed while others were in the shower. The setting for the circulating DHW temperature was higher than necessary, causing undue standby losses.

Although some building operators were highly skilled, other operators could improve their awareness of how the building systems operated and what the appropriate response was for a particular problem. Operators did not log or coordinate service responses and, therefore, could easily undo each others' fixes and over-tweak delicate instruments. Repairs were often makeshift, which focused on symptoms rather than causes, and left systems only semi-operative. Further, operators indiscriminately trusted that occupant complaints were founded and rarely verified the need for system attention.

The need for energy education for building occupants was also apparent. Some occupants were uncomfortable in rooms that were heated to 75 °F because they wore inappropriate clothing for winter conditions or failed to use a blanket on their bed. Other occupants had cold rooms because they barricaded their radiators with furniture. Rarely were occupants aware of opportunities for comfort control, such as thermostats or radiator dampers. Occupant education could reduce many unnecessary service calls.

4 IMPROVEMENTS IMPLEMENTED

After the original retrofits were made, various operational and housekeeping remedies were implemented to improve temperature control in the building and to increase efficiency and decrease the loads of the space and DHW heating systems. Modifications included equipment repair, replacement, augmentation, tune up, and control strategy changes.

Manufacturer specification sheets are included in the Appendix for the installed products used in retrofits. References to manufacturers are made to fully identify the equipment used in this project; these references are not endorsements of the products. After 1 year, all products were operating satisfactorily; other manufacturers' products could perform as well.

1. The boiler control was modified by installing a double-pole, double-throw relay tied to the outside temperature sensor which activates the pumps. This allows the boiler to fire only when the circulator pumps call for heat to the building. This occurs when the temperature drops below a set value, usually 55 °F. An override switch was installed so that it would be possible to reset the original boiler system. Figure 3 shows the relay and override switch installation. An added benefit of this change is that the building operators do not need to turn the boiler off for the summer. It will turn itself off if the outdoor temperature control is set appropriately.

2. A damper motor was installed on the boiler to close the flue damper during the off cycle. The damper is fail-safe with a spring-open mechanism. Figure 4 diagrams the flue damper control. The existing steam pressure control activates the flue damper to open when the minimum setpoint steam pressure is reached. The boiler control circuit is now activated by an end switch on the damper motor, so that the burner can only come on after the flue damper is open.

3. The boiler leak was repaired.

4. The boiler was tuned up. This included cleaning the fire and water sides of the boiler, replacing broken parts (e.g., rusted cross-over tube), cleaning boiler blow down, and adjusting fuel air ratio.

5. The failed steam trap was replaced.

6. The vibrating circulation pump was serviced.

7. Smaller steam valves and actuators were installed at the hot water converters. The valves need to be normally open and linear. The steam valves were sized with the assistance of gathered energy data, indicating a maximum steam flow requirement near 400 lb/hr. Data gathered from another L-shaped barracks without the 1985 retrofits indicated a maximum steam flow requirement near 550 lb/hr for each zone.[2] With the installation at Building 811, the manufacturer agreed to replace the steam valve if the sizing was inappropriate.

8. New pneumatic heating reset controllers were installed and adjusted for the barracks wings. Diagnostic sensors (temperature and pressure meters) were installed in the control lines. Figure 5 shows the control scheme. Table 1 gives the material list for the reset control and steam valves.

[2] Estimated hard calculation from data on Building 813.

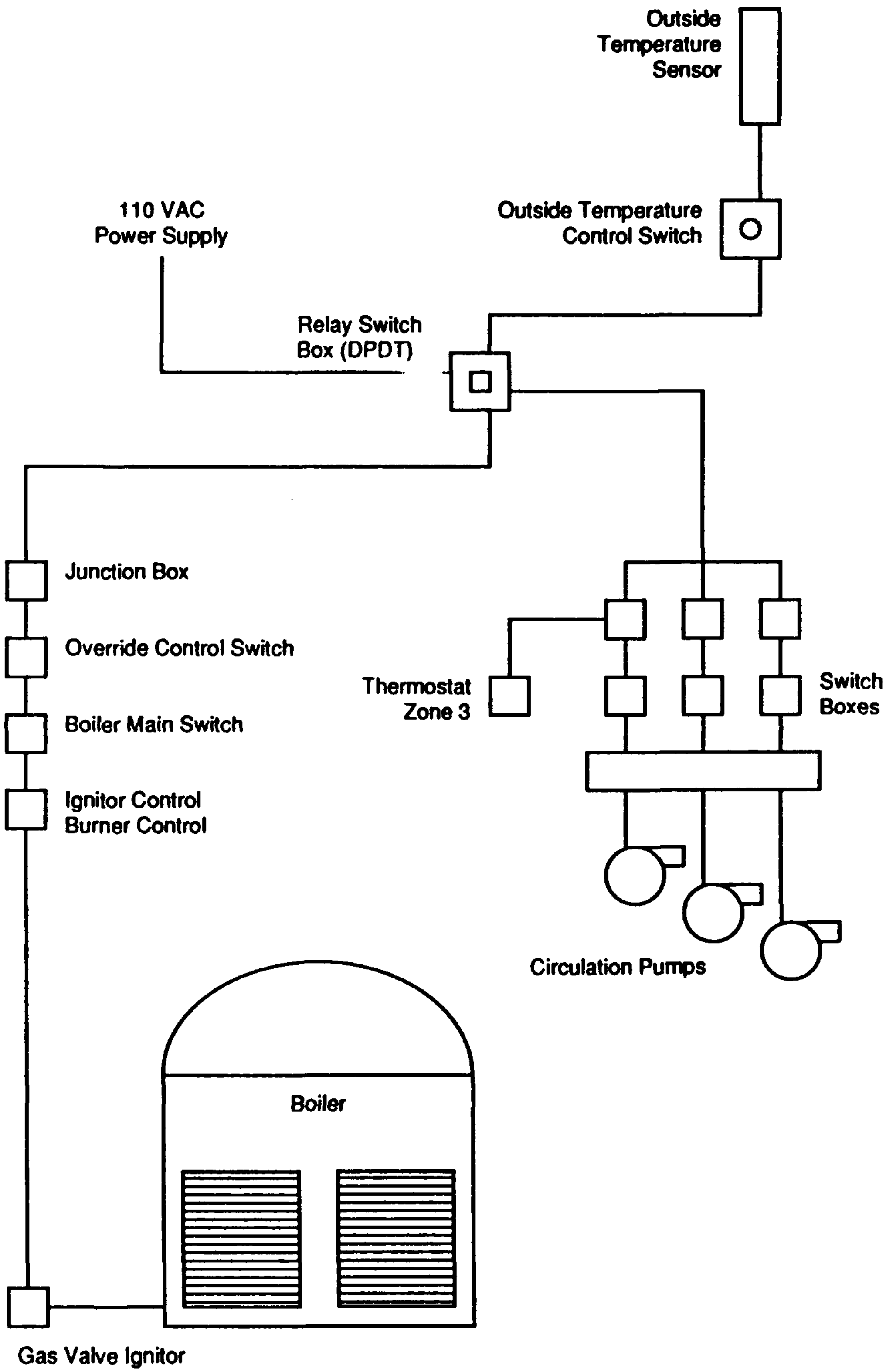
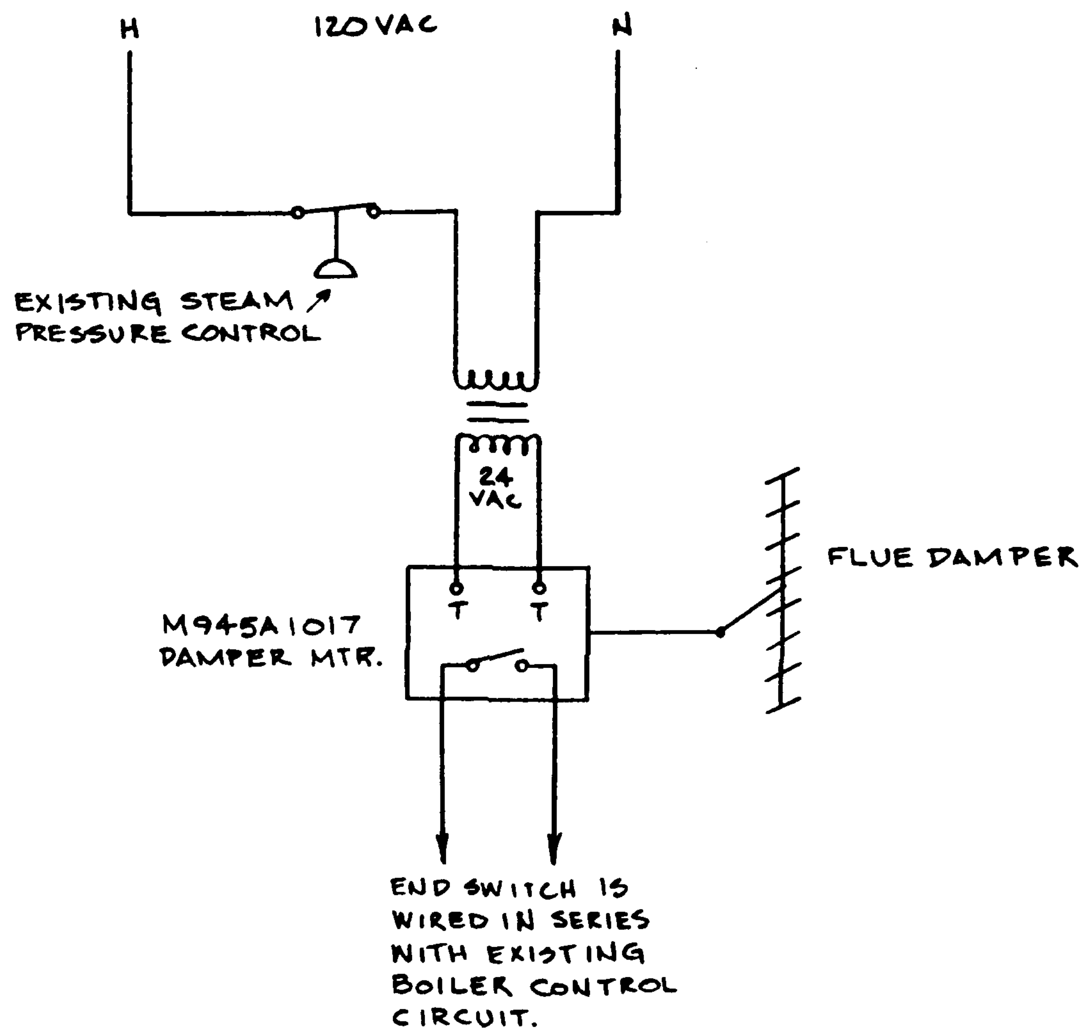


Figure 3. Schematic of Relay and Override Switch Installation.

MATERIAL LIST

1 M945A1017



SEQUENCE: ON A FALL IN BOILER STEAM PRESSURE, PRESSURE CONTROLLER CONTACTS MAKE AND DAMPER MOTOR CIRCUIT IS ENERGIZED. DAMPER MOTOR OPENS FLUE DAMPER, END SWITCH MAKES ENABELING BOILER CONTROL CIRCUIT.

Honeywell

C				304 INVERNESS WAY SOUTH
B				FORT CARSON
REVISIONS		DATE	APPD.	FLUE DAMPER CONTROL
SUPERSEDES	DRAWN BY: JWH	DATE 12-22-87	DRAWING NUMBER 941-17042	REV. 0
SUPERSEDED BY	APPROVED BY:	SHEET 1 OF 1		

56038

81-3212-020 5-80 5000

Figure 4. Flue Damper Control Diagram.

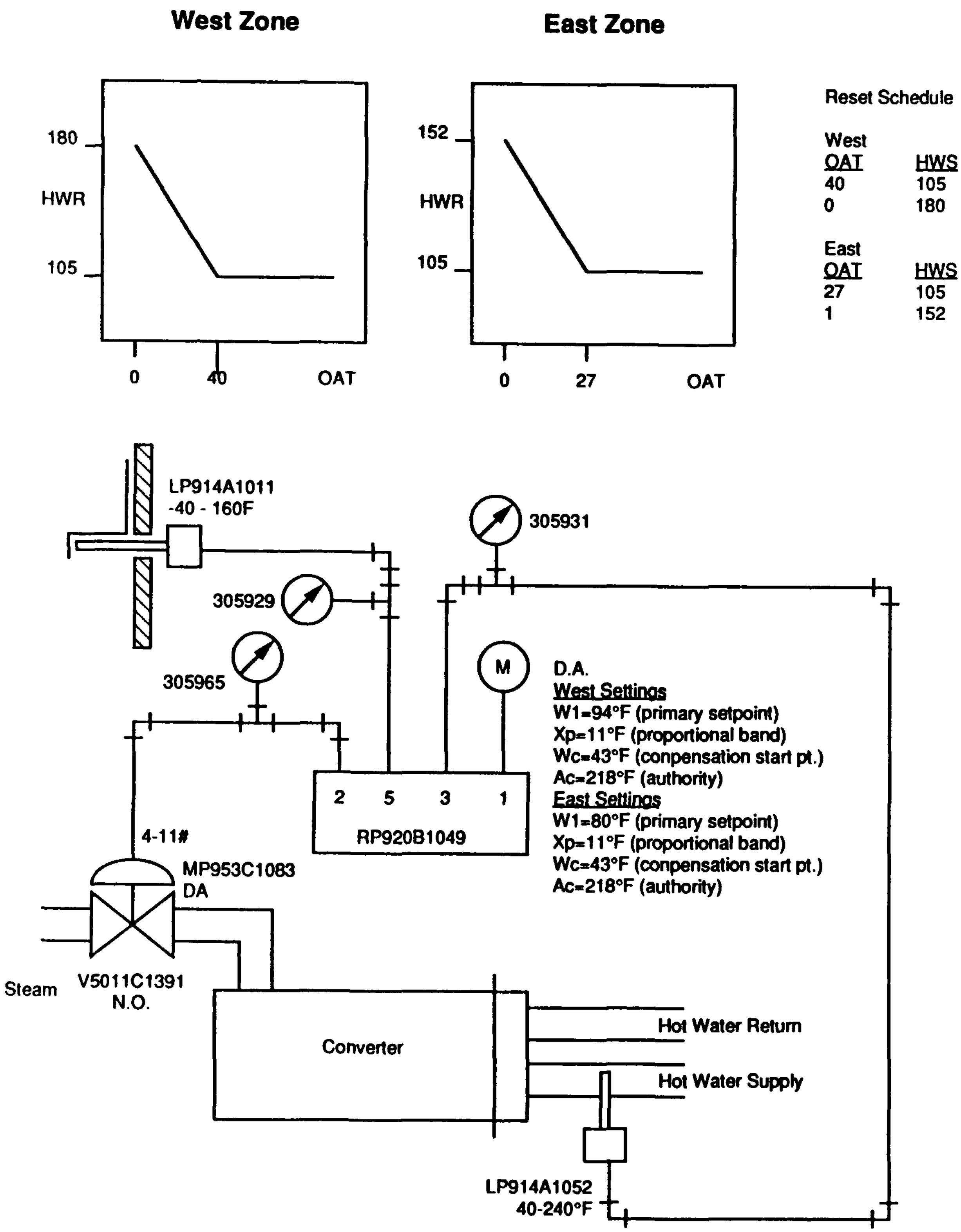


Figure 5. Reset Control Scheme.

The appropriate settings for the reset controllers were originally determined by trial and error. These settings will be different for each building and each controller. Controls governing interior comfort should be adjusted by control specialists. Figures 6 through 11 show the interior temperature trends by zone and the effective reset schedules during these periods. Table 2 shows the zone controller settings which brought about these reset schedules.

9. Broken control wires in zone 3 were repaired. Figure 12 shows the heating control scheme for zone 3.

10. Superfluous controls were removed. Operating controls were labeled.

11. The valving for the DHW was changed to isolate the steam boiler from the water heating function. Figure 13 shows this valving arrangement.

12. The direct-fired gas state water heater was adjusted to increase its firing rate from 450,000 Btu/hr to 500,000 Btu/hr.

13. Anti-scald flow-restricting shower heads (2.75 gpm) were installed in the 15 showers in the building. During installation, the absence of zoned water shut-off valves caused some difficulty. To keep the building operational during shower retrofit, existing shower valves were left in the piping (handles removed) and mixing valves were installed downstream. See Figures 14 and 15.

14. The DHW temperature setting was turned down from 180 °F to 160 °F.

15. At various times throughout the investigation, zone 3 experienced both underheating and overheating. Figure 16 illustrates the zone 3 floor plan. This zone consists of three different subzones: (1) the classroom area, men's room and medical treatment room, with perimeter heat controlled by a single thermostat on the north wall, (2) the ladies' room with perimeter hydronic heat controlled by a separate thermostat in the ladies' room, and (3) the first-aid waiting and sick bay area with no perimeter heating. This area is heated by a steam unit heater with its own thermostat.

In one case, underheating in the classroom area was caused by the combination of an incorrectly set thermostat (which was set near 50 °F rather than 68 °F), a closed steam valve that prevented steam from servicing the zone heat exchanger, and a broken electric control wire to the modulating steam valve. This underheating was corrected by repairing these problem areas. Another case of underheating was also caused by an incorrectly set thermostat. The thermostat in the ladies' room was turned completely down and occupants were unaware of its existence. This problem was corrected by resetting the thermostat.

A third case of underheating was caused by a broken thermostat control on the fan of the steam space heater. The fan ran continuously, even during the off cycle of the steam flow to the coil. This caused circulation of cool air and increased occupant discomfort. The thermal switch on the condensate return was modified so that the fan would only operate when the coil was at setpoint.

Overheating in zone 3 was caused by high aquastat settings and valving which bypassed the thermostat's control capabilities. The thermostat in the classroom was turned down and a complaint call was made. To provide heat, the maintenance person opened the by-pass valve from zone 2 to zone 3 (Figure 17). With valve 11 open and valve 6 closed, the zone 2 pump supplies all the water to zone 2 and zone 3. The water returns from these zones through the hot water converters and is mixed before re-entering the zone 2 pump. The hot water converter on zone 2 is set up for reset control, and for zone 3, it is set at a constant temperature of 195 °F. Therefore, the 195 °F water is mixing with the return of the zone 2 water which makes the zone 2 water too hot.

With this arrangement two anomalies occur: zone 2 overheats because supply water temperatures are too high, and zone 3 overheats because the flow to that zone is continuous. It would normally be cycle controlled by the thermostat. To correct these problems the valving was changed to the original settings and the heating water aquastat was adjusted from 195 °F to 160 °F. The valve handles were removed on valves 11 and 6 to prevent the maintenance people from easily opening these valves as part of a "quick fix" solution. Associated valves were labeled.

16. At times during the investigation, a combination of underheating and overheating occurred in the barracks wing. A call for heat in some rooms prompted an adjustment of the reset controls to provide higher temperature heating water. Upon inspection of the cold rooms, various causes were revealed concerning occupants' lack of awareness and education. Suggestions were made on furniture placement, bedding, and clothing adjustments to improve comfort. When the hot water heating system was found to be airbound, the piping was bled of air with manual valves on the radiators. In all these cases controls were reset to their original settings.

Table 1

Material List. Reset Control and Steam Valve

Qty	Honeywell Part Number	Description
2	LP914A1011	Sensor
2	LP914A1052	Sensor
2	MP953C1083	Actuator
2	RP920B1049	Pneumatic Controller
2	V5011C1391	2-Way Steam Valve
2	305929	-40 to 160 °F Gauge
2	305931	40 to 240 °F Gauge
2	305965	0 to 30 PSI Gauge

Table 2

Control Settings at Building 811

Zones		
East Side	West Side	South Side
W1=94	W1=80	T=160
Ac=2.18	Ac=2.18	
Wc=43	Wc=43	
Xp=11	Xp=11	

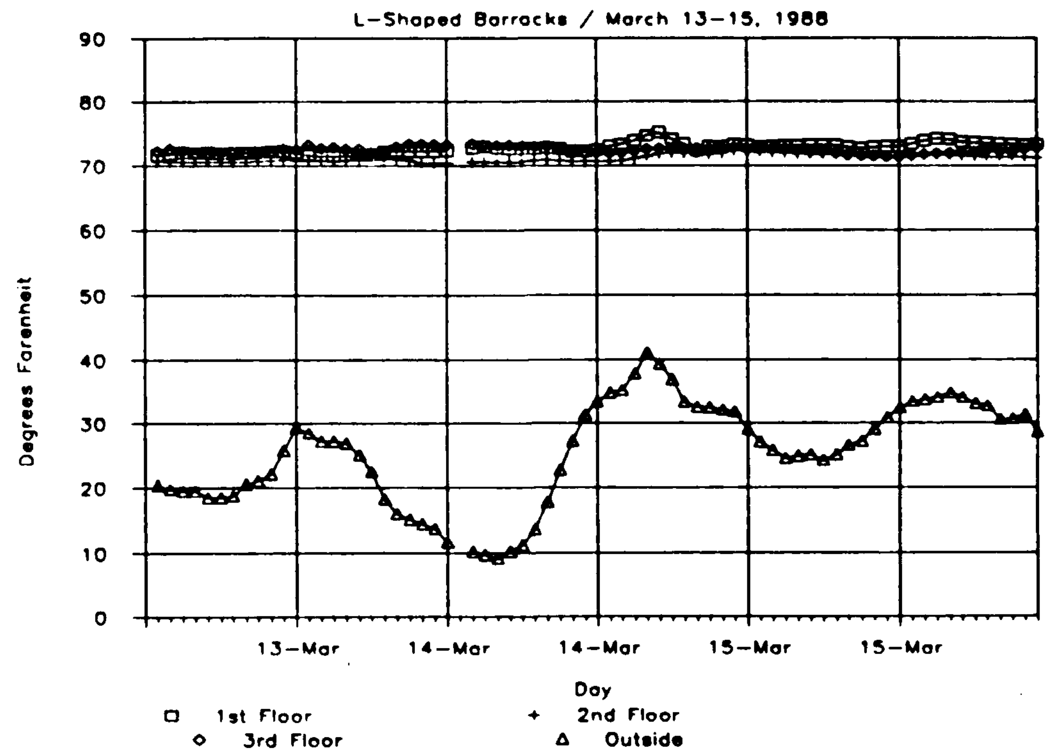


Figure 6. West Zone Interior and Exterior Temperature Profiles.

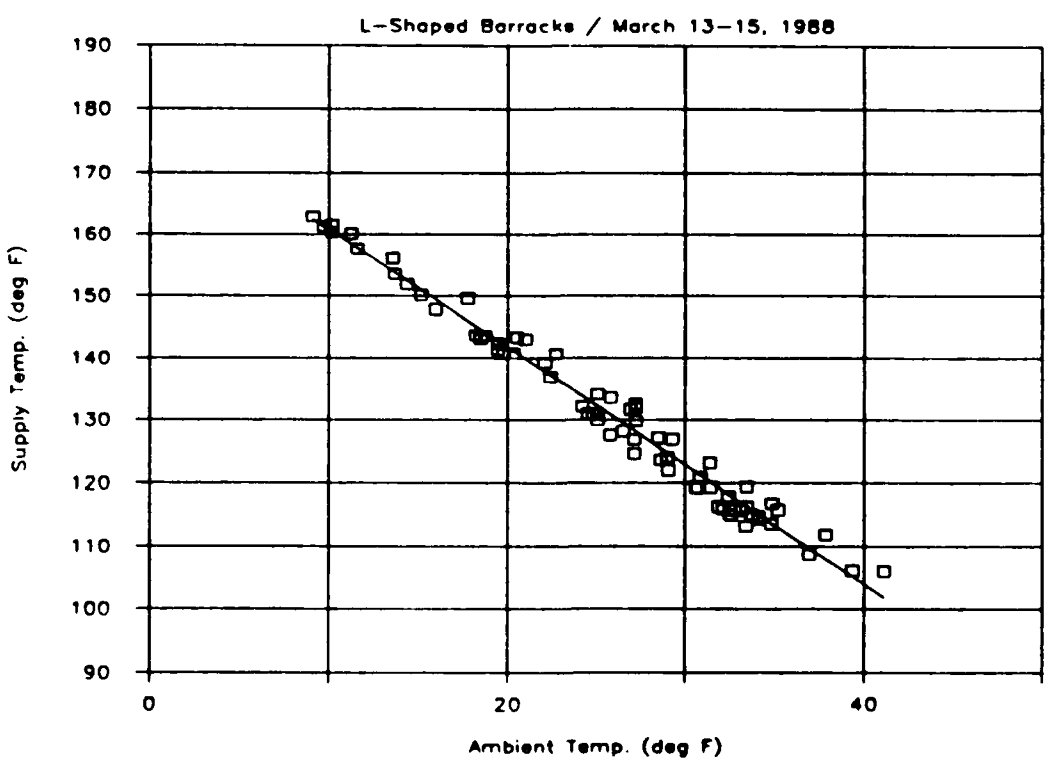


Figure 7. West Zone Reset Schedule.

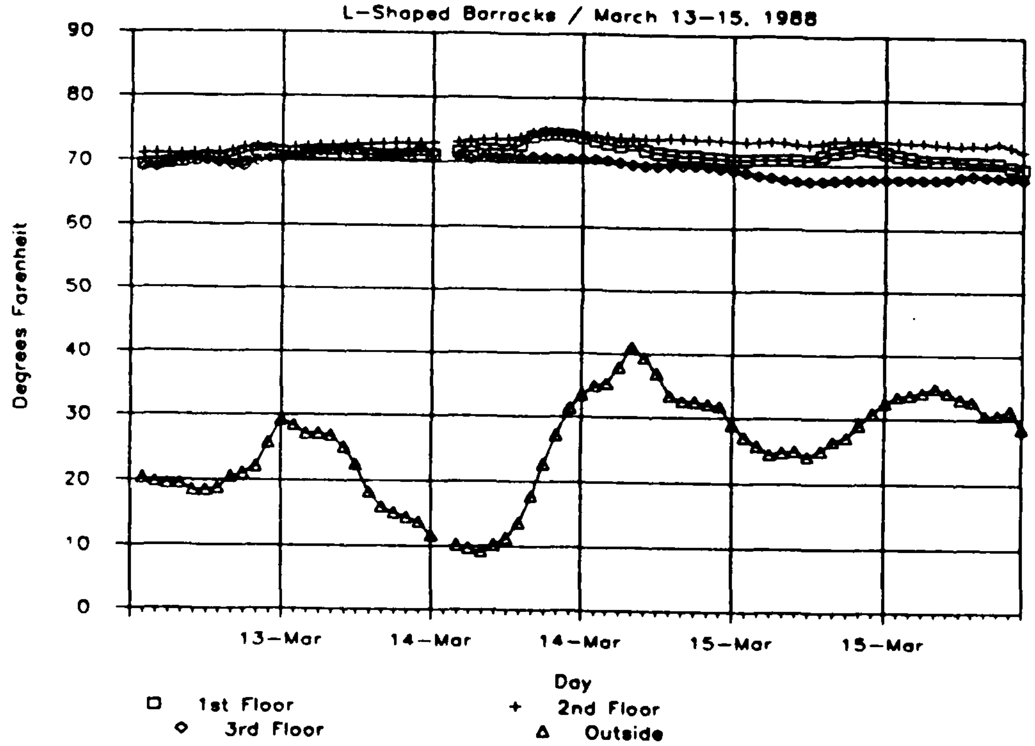


Figure 8. East Zone Interior and Exterior Temperature Profiles.

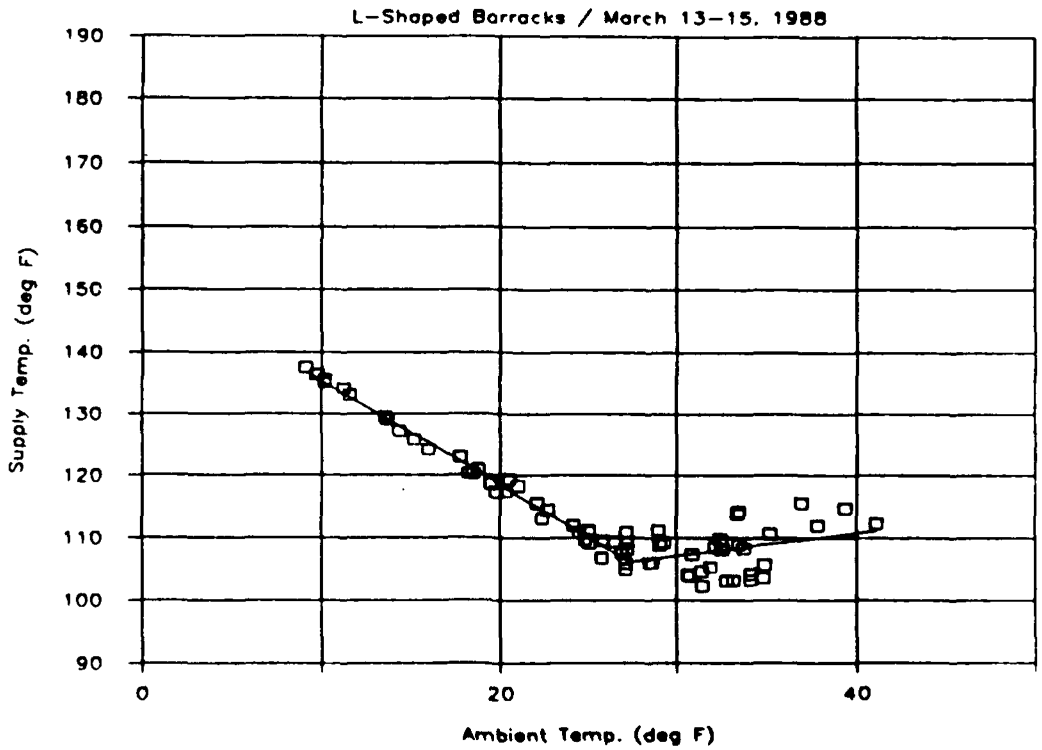


Figure 9. East Zone Reset Schedule.

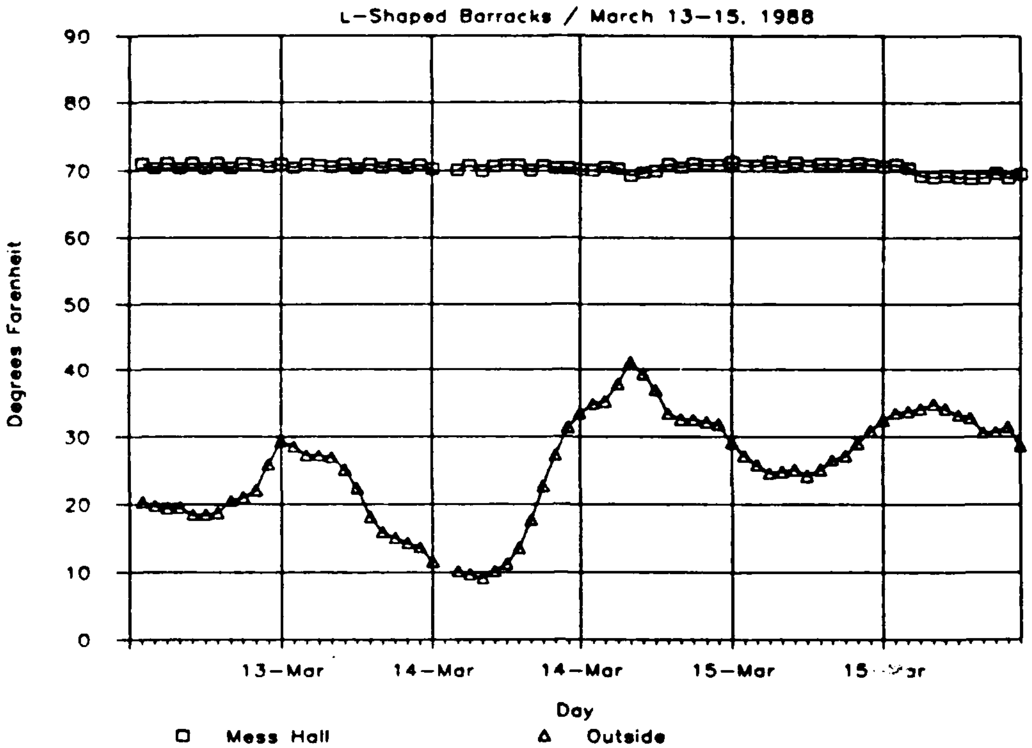


Figure 10. South Zone Interior and Exterior Temperature Profiles.

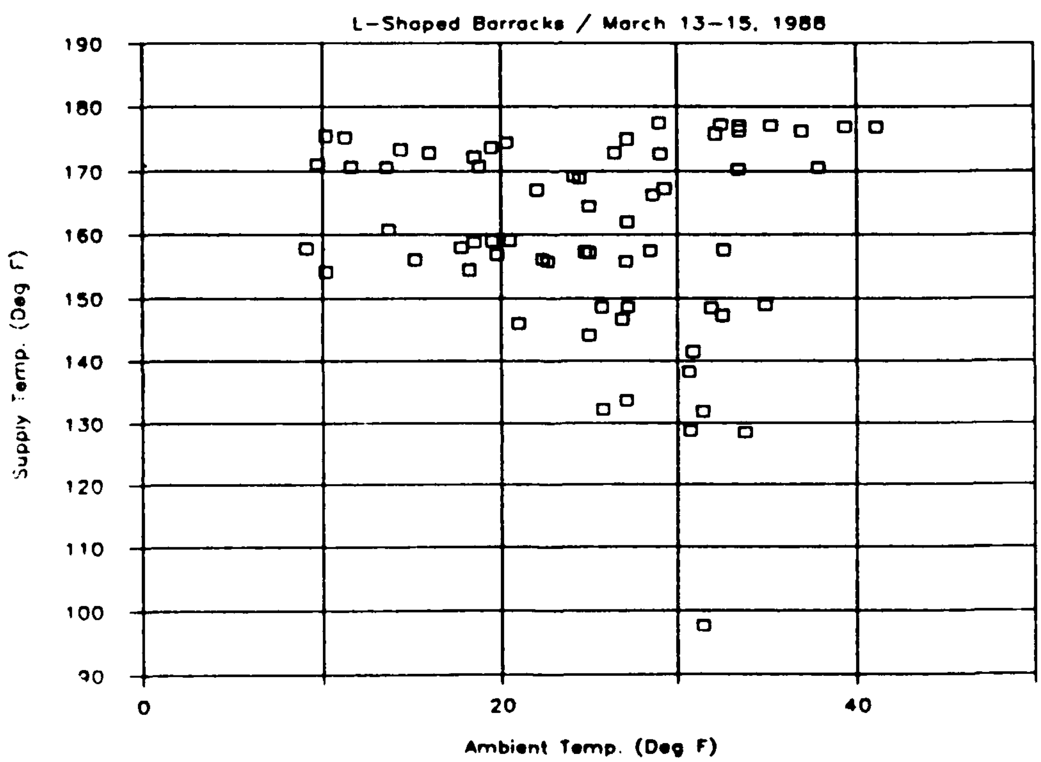


Figure 11. South Zone Heating Hot Water Supply Temperature.

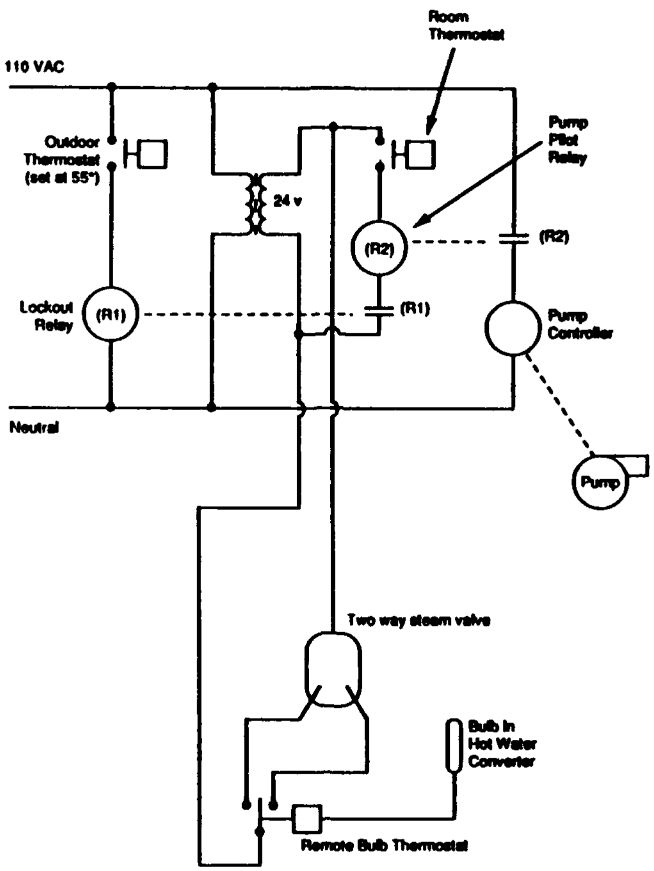


Figure 12. Zone 3 Wiring Diagram, Building 811.

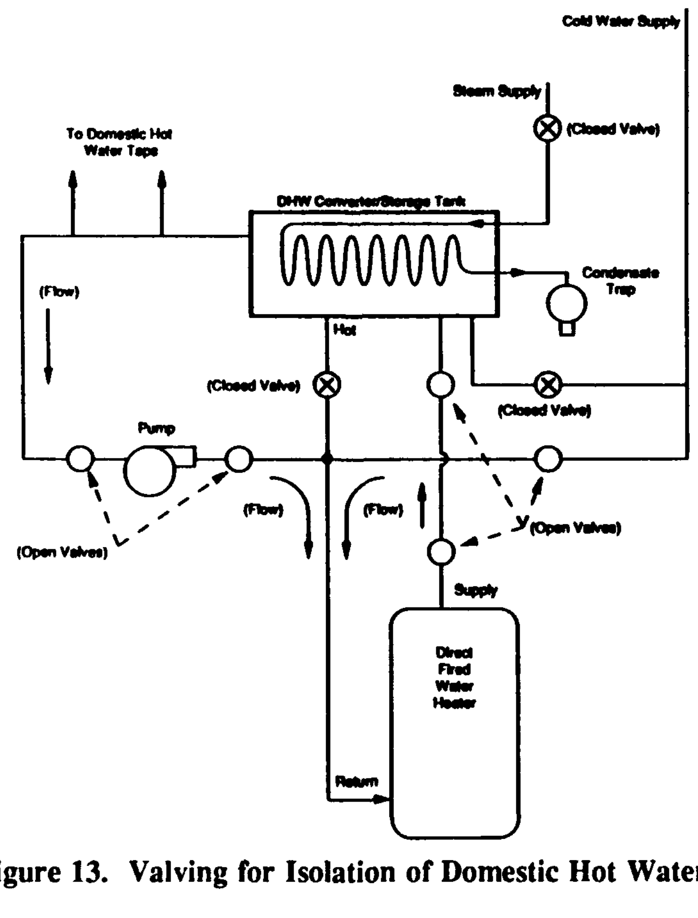


Figure 13. Valving for Isolation of Domestic Hot Water.

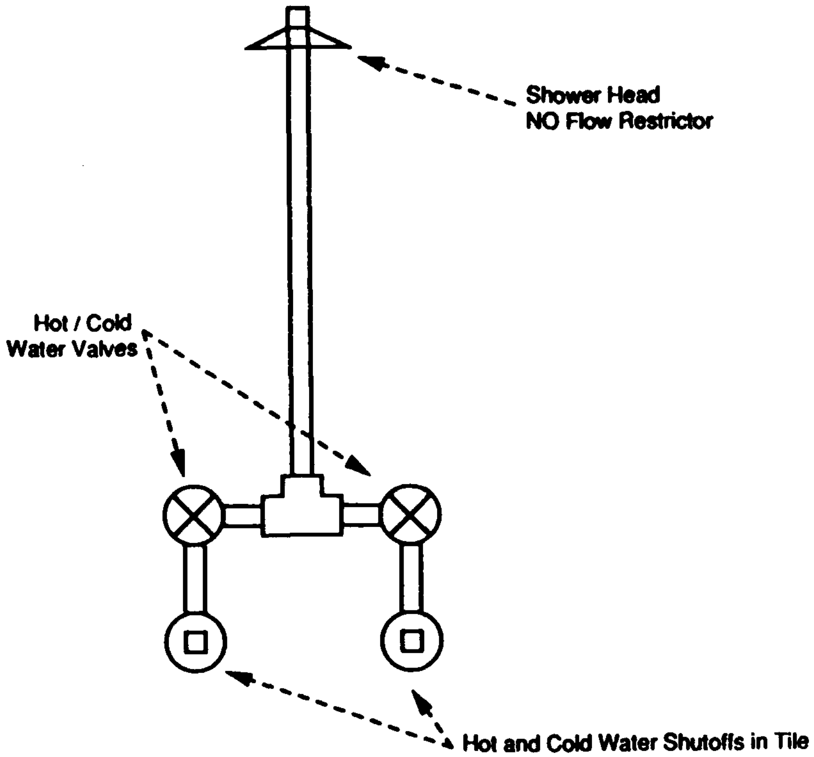


Figure 14. Shower Piping Before Retrofit.

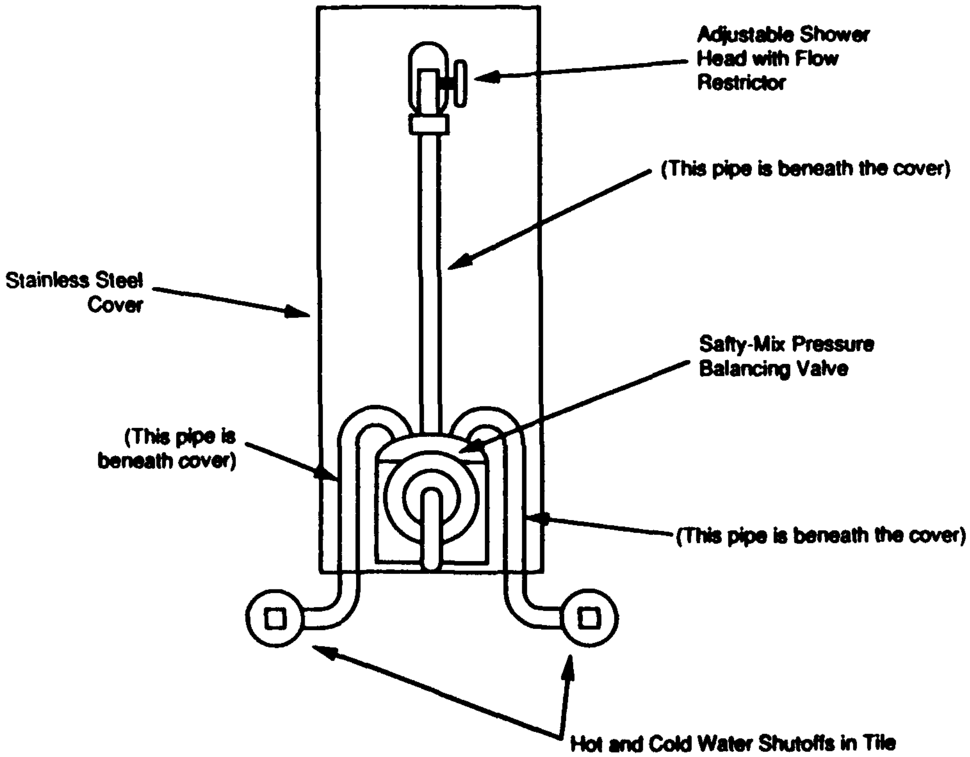


Figure 15. Shower Piping After Retrofit.

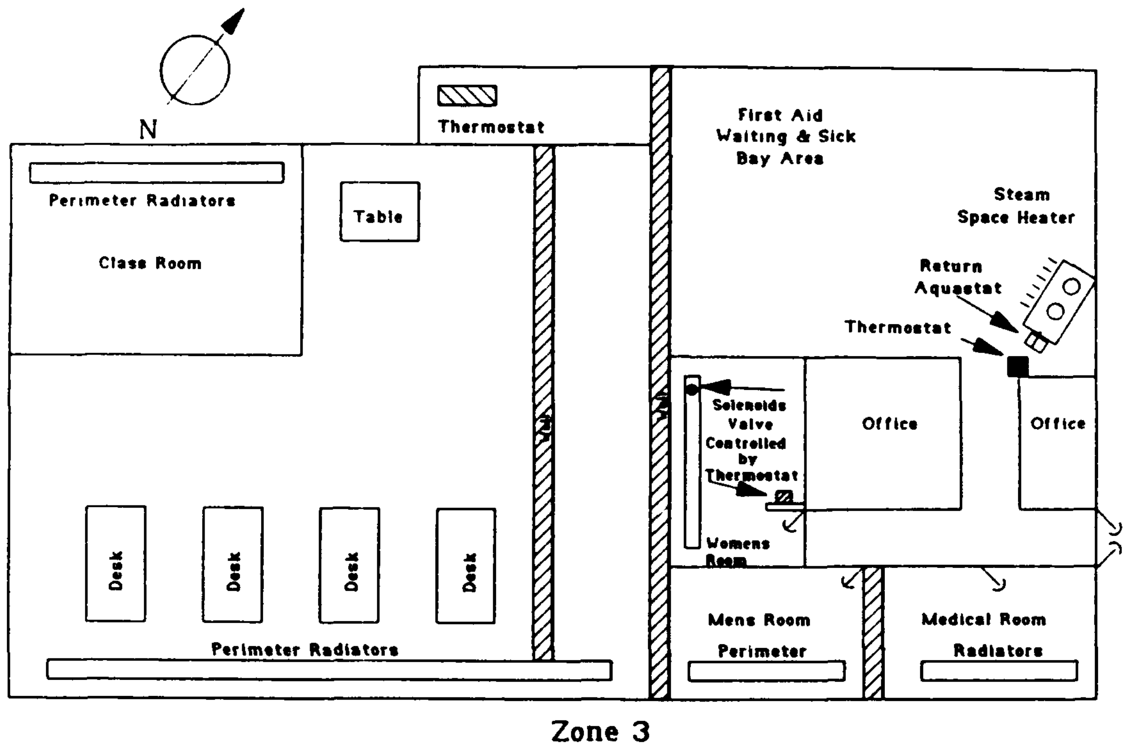


Figure 16. Illustration of Zone 3 Floor Plan.

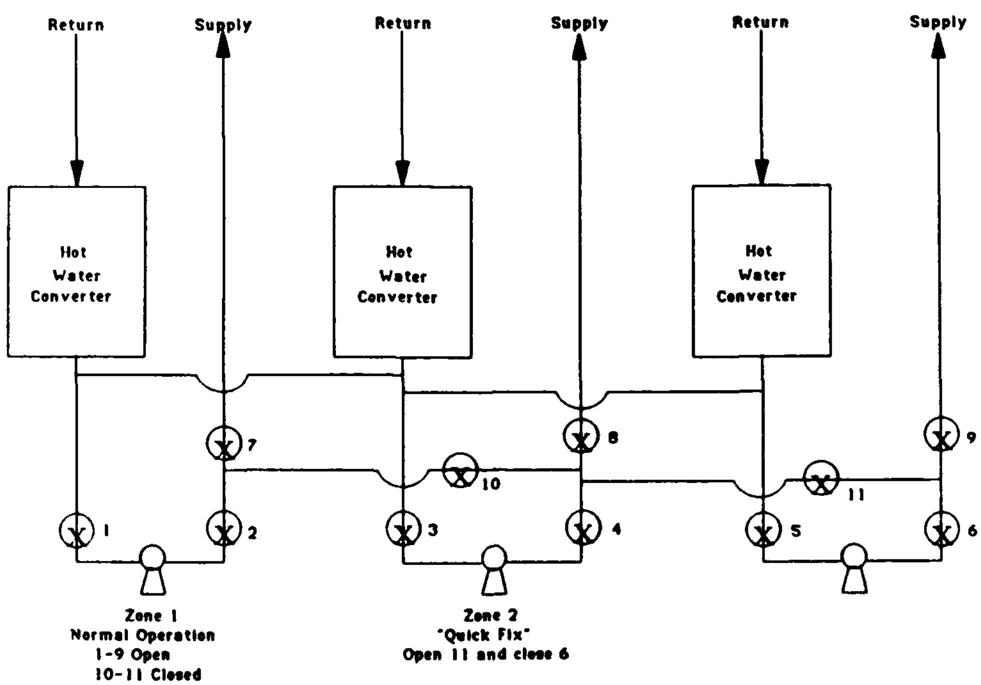


Figure 17. Illustration of Bypass Valves Between Zones.

5 DATA ANALYSIS

Data collected from this field test over the 1987-1988 heating season was reviewed to assess improvement. Analysis results were encouraging. Improvements in interior temperature trends, control capabilities, system part-load efficiencies, and heating and DHW loads resulted in substantial fuel savings.

Enhanced Controls/Improved Interior Temperature Trends

The standard L-shaped barracks design at Fort Carson provides heating with hot water at a fixed setpoint, usually near 200 °F, regardless of the thermal load (differential indoor/outdoor temperature) on the building. The resultant overheating requires occupants to open windows for comfort in all but the coldest weather. Initial retrofit efforts to reset control on the heating hot water in the L-shaped barracks yielded limited success. Several factors hampered these efforts:

- the oversized steam valves on the hot water converters (causing on/off rather than modulating control)
- the complexity of the controllers (making adjustments difficult)
- and the lack of coordination and education of the service staff.

During the improved operations period, interior temperatures in the test building were brought into the comfort range. This was accomplished through (1) new, properly adjusted heating controls that reset heating water temperatures as outdoor temperatures change; (2) appropriately sized steam valves on the hot water converters which allow modulated steam control, yielding fewer temperature excursions on heating hot water and room temperatures; and (3) diligent data monitoring and collaboration with site service staff.

Figure 18 shows a dramatic example of the enhanced control capabilities during the improved operations period. The hot water reset schedule (heating hot water supply temperature versus outside air temperature) with the new set of reset controllers and new steam valves is significantly lower in temperature, more shallow in slope, and tighter in throttling range than the previous year's attempt at reset control. This example is not representative of the entire heating season, however, since insufficient coordination between USACERL and base personnel, before the on-site monitoring period, led to inappropriate and frequent adjustment of control settings. In spite of these difficulties, reset control improvement was still significant over the previous year's attempt.

Figure 19 shows typical temperature improvements obtained in the building. The improved operations period, May 1987 through May 1988, shows temperatures averaging about 7 °F cooler in the heating season (September through May) than the operations between May 1986 and May 1987. Temperature reductions for the entire building averaged about 5 °F during this period.

Part-Load Efficiency

Based on the system load, heating system efficiency varies. At 100 percent load, the system is operating at its maximum efficiency, while at less loaded conditions, the efficiency decreases until it reaches 0 percent efficiency at no load. An improvement in a system's efficiency needs to be evaluated over the operating range or part-load conditions of the system.

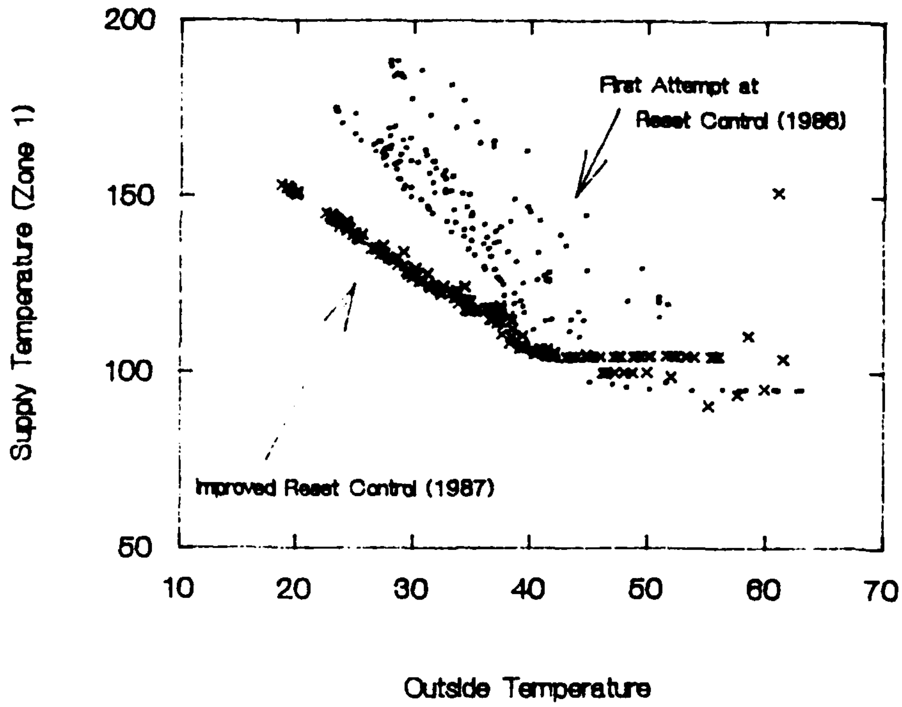


Figure 18. Reset Control.

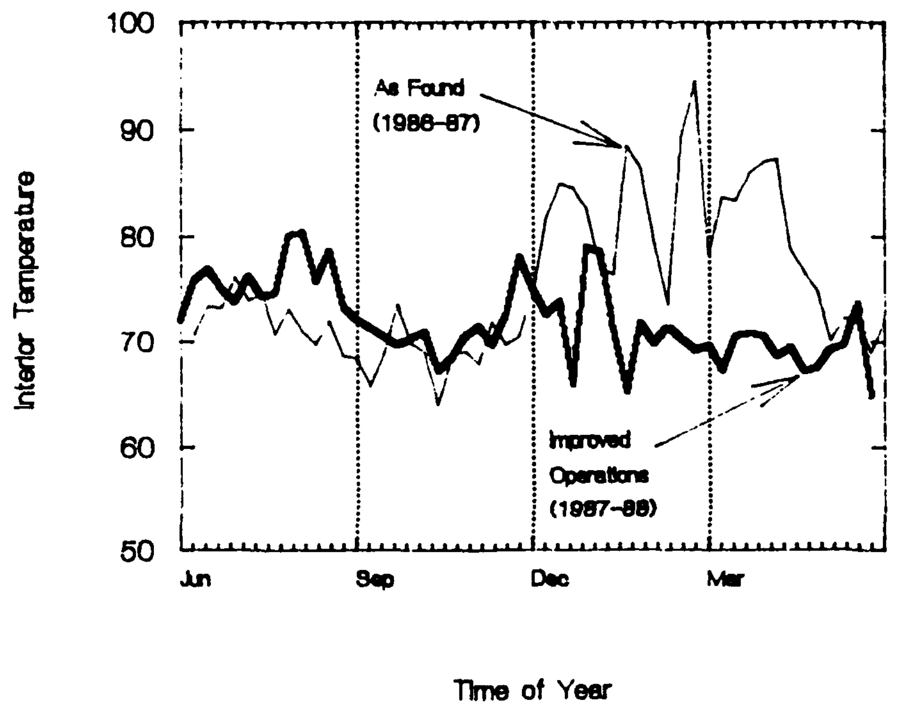


Figure 19. Interior Temperature Profiles.

Several system modifications during the improved operations period lead to increased part-load efficiencies of the combined space heating and DHW heating system. These modifications included:

- installing a flue damper on the boiler to minimize off cycle losses
- revalving the DHW heating system to isolate the domestic water heating function to the direct-fired gas unit
- rewiring the boiler controls to produce steam for heating only during heating conditions
- tuning up the boiler, including adjusting the fuel/air ratio, to maximize steady state efficiency
- repairing the leaks in the boiler
- repairing failed steam traps to reduce venting of live steam.

Figure 20 shows the part-load data for the original and improved operations. The comparison of part-load data was challenging since the original operations of the heating/DHW system did not clearly show efficiency as a function of system load. The reason for this is not known. Improved operations did show a strong, classical relationship of increased efficiency with increased load. For comparison, the classical form of the part-load curve was superimposed on the original data. The curve fit is extremely poor. With this qualification, the following conclusions were drawn. The improved operations curve is both higher and less scattered than the original curve, yielding more consistent and, on average, more efficient operation over the operating range of the system.

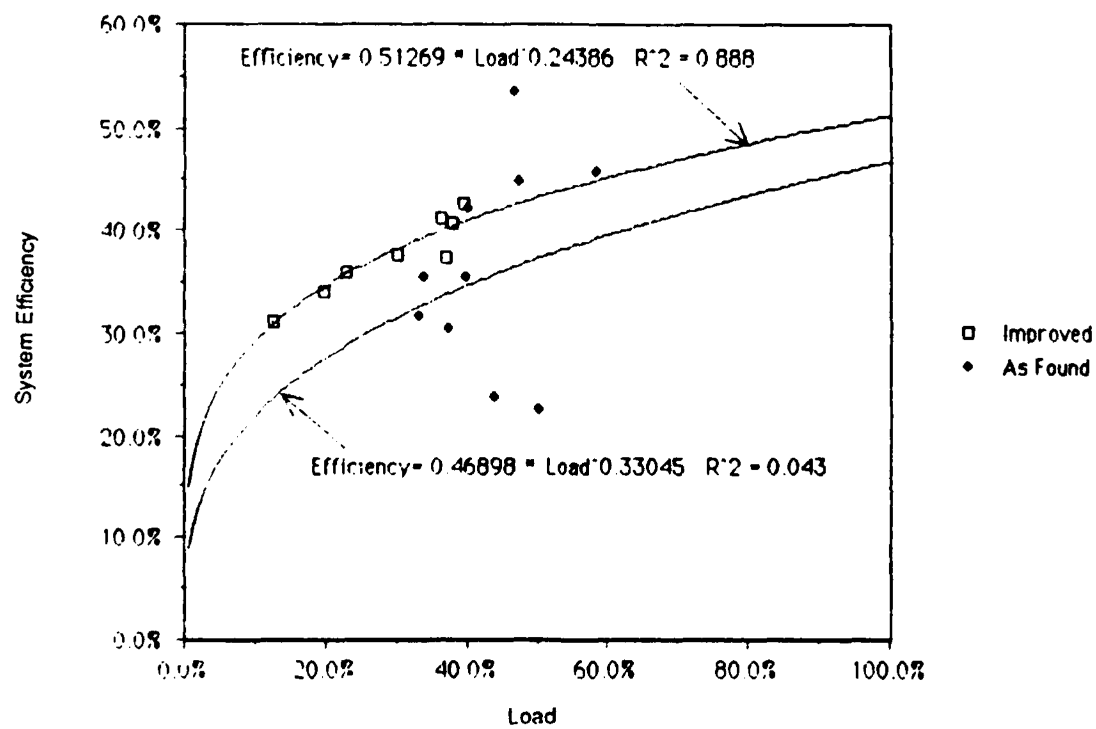


Figure 20. Part-Load Efficiency Curves.

Heating Load Reductions

Heating load reductions occurred because of reduced interior temperatures which caused occupants to close the windows. The heating load reduction during the improved operations period was 1033 MBtu/yr or 50 percent of the previous year's load corrected for weather differences. (Complete data tables are included in Tables 3 through 5.)

Domestic Hot Water Energy Savings

Savings in energy for DHW production occurred due to the installation of restricted flow shower heads, which reduced the thermal load, and reduced water temperature settings (from 180 °F to 160 °F), which decreased the standby losses. The DHW load reduction during the improved operations period was 86 MBtu/yr or 11.7 percent of the previous year's load. This estimate is conservative since the reduced flow shower heads were only installed during 6.5 months of the 12-month comparison period.

System Efficiency

Overall annual system efficiency decreased a nominal 2 percent, from 40.6 to 38.5 percent.* This 2 percent is the net effect of decreasing system loads by 34 percent and increasing part-load efficiencies by 5 to 7 percent. Anticipated system efficiency reductions, due only to decreased load, are on the order of 10 percent (see Figure 20) which further substantiates the part-load improvements.

Table 3

Savings of Initial L-Shaped Barracks Retrofit Package, Normalized to 1987-88 Heating Season

	Annual Energy Totals				Energy Savings	Percent Savings
Energy Type	Bldg 811† MBtu	Bldg 812† MBtu	Bldg 813† MBtu	Mean Ref† MBtu	811† -vs- Mean Ref† MBtu	811† -vs- Mean Ref† MBtu
Gas:	6281.6	8734.7	7920.5	8327.6	2046.0	24.6%
Heating Total:	2055.4	2655.9	2434.5	2545.2	489.9	19.2%
DHW:	747.9	832.4	823.6	828.0	80.1	9.7%

† These data are from 1986-87, and have been normalized to the 1987-88 heating season.

Notes:

Building 811 == Test
Building 812 == Reference
Building 813 == Reference

86-87 is June 1986 - May 1987
87-88 is June 1987 - May 1988

1 KBtu == 10^3 Btu
1 MBtu == 10^6 Btu

1986-87 HDD = 5968
1987-88 HDD = 6095

*Efficiencies are calculated by [(heating total)+(DHW total)]/(gas total).

Table 4

Incremental Savings of Improved Operations

Annual Energy Tests			Energy Savings	Percent Savings
Energy Type	Bldg 811† MBtu	Bldg 811† MBtu	811 -vs- 811† MBtu	811 -vs- 811† MBtu
Gas:	4540.1	6281.6	1741.5	27.7%
Heating Total:	1022.5	2055.4	1032.9	50.3%
DHW:	646.3	732.3	86.0	11.7%

† These data are from 1986-87, and have been normalized to the 1987-88 heating season.

Notes:

Building 811 == Test
Building 812 == Reference
Building 813 == Reference

86-87 is June 1986 - May 1987
87-88 is June 1987 - May 1988

1 KBtu == 10^3 Btu
1 MBtu == 10^6 Btu

1986-87 HDD = 5968
1987-88 HDD = 6095

Table 5

Savings of Total L-Shaped Retrofit:
Initial Retrofit Plus Improved Operations

Annual Energy Tests			Energy Savings	Percent Savings
Energy Type	Bldg 811† MBtu	Bldg 811† MBtu	811 -vs- 811† MBtu	811 -vs- 811† MBtu
Gas:	4540.1	8327.6	3787.5	45.5%
Heating Total:	1022.5	2545.2	1522.7	59.8%
DHW:	646.3	828.0	181.7	21.9%

† These data are from 1986-87, and have been normalized to the 1987-88 heating season.

Notes:

Building 811 == Test
Building 812 == Reference
Building 813 == Reference

86-87 is June 1986 - May 1987
87-88 is June 1987 - May 1988

1 KBtu == 10^3 Btu
1 MBtu == 10^6 Btu

1986-87 HDD = 5968
1987-88 HDD = 6095

Fuel Savings

Fuel savings during the improved operations period were significant. Gas consumption was reduced by 1741 MBtu/yr, or 28 percent of the previous year's consumption, adjusted for weather conditions.

Return on Investment

The measured fuel savings of 1741 MBtu/yr corresponds to an annual dollar savings of $6094/yr, if natural gas can be purchased at $3.5/MBtu. The initial investment for these improvements is estimated at $19,150, yielding a simple payback period of 3 years. Over an assumed 15 year life of the building, this investment would pay for itself 5 times. However, continued return on the investment requires minimal upkeep of the mechanical equipment including:

- periodic boiler tune up,
- elimination of air from the hydronic heating system,
- servicing of the air compressor which supports the controls (bleeding out excess water, supplying oil when needed), and
- repair of equipment as it fails (especially steam traps).

Continued return on the investment also assumes informed responses to heating calls and lack of vandalism to any of the installed equipment.

6 CONCLUSIONS AND RECOMMENDATIONS

Potential energy savings from improved building operations are high. In this test, fuel savings of 1741 MBtu/yr from improved operations (Table 4) nearly equalled fuel savings of 2046 MBtu/yr resulting from the initial retrofit on an as-operated building (Table 3). The cost of improved operations is significantly lower than the cost of envelope improvements, and improved operations are essential for envelope improvements to achieve their full savings potential. The lessons learned in the L-shaped barracks are not unique; neither is the level of building operations found at this test installation. There is vast opportunity for fuel and dollar savings throughout the Army by recognizing the cost effectiveness of routine mechanical upkeep and enhancements on outdated methods of heating control, and by educating occupants and operators.

It is recommended that the improvements implemented in Building 811 be applied to other similarly constructed and operated buildings and that the retrofits detailed in this document, or similar changes, be used where appropriate. Because not all L-shaped barracks are exactly alike, detailed building inspections should take place to verify original conditions.

Much of the opportunity for savings depends on adequate occupant and operator education and coordination. To maximize savings, increase occupant comfort, and reduce service calls, it is recommended that:

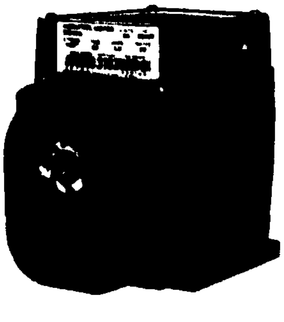
- job-specific training programs for building operators (e.g., troubleshooting guidelines and operator testing) be investigated
- occupant education programs be expanded
- clothing, bedding, and furniture positioning be adjusted
- selected occupants be taught the heating control capabilities in these buildings, (e.g., thermostats in the south zone, radiator dampers which could be made operable, fan controls on cooling coils, and air bleed valves on hydronic heating loops)
- an in-building log book of service calls, including reported problems and responses, be kept
- a designated controls staff, exclusively authorized to make adjustments to building controls, be appointed
- air be permanently eliminated from the heating system by increasing the water pressure and bleeding the piping (If air introduction continues to be a problem, the installation of automatic air bleed valves on hydronic heating loops should be investigated.)
- radiator damper chains be repaired.

METRIC CONVERSION FACTORS

1 Btu	=	1055.87 J
°F	=	(°C + 17.78) × 1.8
1 gal	=	3.78 L
1 in.	=	25.4 mm
1 lb	=	0.453 kg
1 psi	=	6.89 kPa
1 sq ft	=	0.093 m^2

APPENDIX:

Manufacturers' Specification Sheets



M945A-D,F,G Modutrol Motors

Modulating, spring-return motors used to operate dampers and valves.

Integral helical spring returns motor shaft to normal position (full open or full closed) on power interruption. Stroke: Fixed 90 or 160 degree. Timing: 30 or 60 sec. Voltage and Frequency: 24 V, 50/60 Hz. Maximum Operating Torque: 50 lb.-in. [5.7 N·m] (25 lb.-in. [2.8 N·m] max. at auxiliary end). Ambient Temperature Range: Minus 35 F to plus 130 F [minus 37 C to plus 54 C] at 25% duty cycle. Crankshaft: Double-ended, 3/8 in. [10 mm] square, untapped. Approximate Dimensions: 7-5/32 in. [182 mm] high, 5-5/8 in. [143 mm] wide, 9-1/4 in. [235 mm] deep. Listed by Underwriters Laboratories Inc.—M945C,D; Canadian Standards Association certified—M945D.

ACCESSORIES:
See PARTS and ACCESSORIES, page 201.

AUXILIARY SWITCH RATINGS FOR M945C,D (A):
One spdt V3 switch—

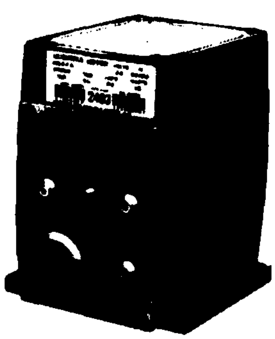
ONE CONTACT[a]	120 V	240 V
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

[a]40 VA pilot duty, 120/240 Vac on opposite contact.

**TRADELINE model.*

Order Number	Power Consumption W	Power Consumption VA	Internal Balance Circuit[a]	Normal Position	Stroke (degrees)	Timing (sec)	Includes
*M945A1017	23	30.0	Yes	Closed	160	60	
M945A1082	23	30.0	Yes	Closed	90	30	
M945B1057	20	25.5	No	Closed	160	60	
M945B1065	20	25.5	No	Closed	90	30	
M945C1015	20	25.5	No	Closed	160	60	2 spdt auxiliary switches
M945D1006	23	30.0	Yes	Closed	160	60	2 spdt auxiliary switches
M945F1004	23	30.0	Yes	Open	160	60	
M945G1037	20	25.5	No	Open	160	60	

[a]Models less balance circuit are for use with electronic panels, reset systems, and R927C Balance Relay (with external Q181 Auxiliary Pot).



M644A-E Modutrol Motors

Reversing 2-position motors used to operate valves and dampers.

M644 motors are used with series 60, 2-position controllers (spdt switching). Crankshaft: 3/8 in. [10 mm] square, double-ended, untapped. Ambient Temperature Range: Minus 40 F to plus 130 F [minus 40 C to plus 54 C] at 25% duty cycle. Approximate Dimensions: 7-5/32 in. [182 mm] high, 5-5/8 in. [143 mm] wide, 7-7/16 in. [189 mm] deep. Listed by Underwriters Laboratories Inc.—M644A,B,D,E; Canadian Standards Association certified—M644B,D,E,F.

continued next page

Figure courtesy of ITT McDonnell & Miller.

M644A-E continued

TORQUE:

Timing		Normal Running Torque		Break-away Torque[a]	
90 deg. stroke	180 deg. stroke	lb.-in.	N·m	lb.-in.	N·m
15 sec	30 sec	75	8.5	150	17.0
1/2,1,2 min	1,2,4 min	150	17.0	300	34.0

[a]The maximum torque available to overcome occasional large loads such as a seized damper or valve. MOTOR NOT TO BE USED CONTINUOUSLY AT THIS RATING.

AUXILIARY SWITCH RATINGS (A):
One spdt V3 switch—M644D,E

ONE CONTACT[a]	120 V	240 V
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

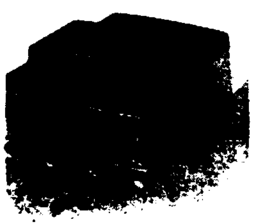
[a]40 VA pilot duty, 120/240 Vac on opposite contact.

See PARTS and ACCESSORIES, page 201.

**TRADELINE model.*

Order Number	Voltage (50/60 Hz)	Power Consumption W	Power Consumption VA	Timing	Stroke (degree)	Includes
*M644A1016	24	15	16.6	60 sec	160	
M644A1024				30 sec	90	
M644B1049	120			30 sec	160	
M644C1006	24	15	16.6	15 or 30 sec[b]	Sel. 90 or 160	
M644C1014[a]				2 or 4 min[b]	Sel. 90 or 160	
M644D1005[a]	24	15	16.6	30 or 60 sec[b]	Sel. 90 or 160	2 spdt auxiliary switches
M644E1012[a]	24	15	16.6	60 sec	90	1 spdt auxiliary switch

[a]Shipped in 90-degree position.
[b]Shorter timing applies when 90-degree stroke is selected.



130810
Cover Mounted Transformer

40 VA transformer used to supply power to a 24-volt motor.

Replaces standard motor top cover on M744, M745, M845, M644, M941, M944, M945, M954, M955 (old series motors). Listed by Underwriters Laboratories Inc.; Canadian Standards Association certified (when used with motor).

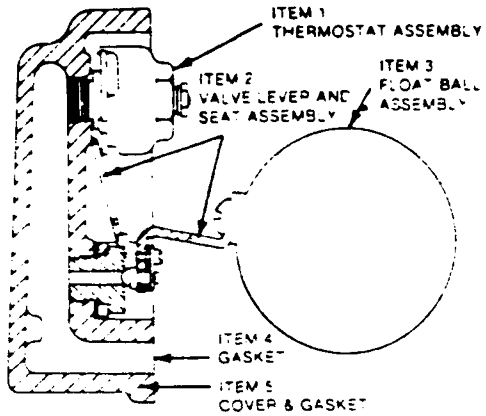
** TRADELINE model.*

Order Number	Primary Voltage
130810A	120 V, 60 Hz
*130810B	120/208/240 V, 60 Hz
130810C	220 V, 50 Hz
130810H[a]	24 V, 50/60 Hz

[a]Use with W936 Multizone Logic Panel.

Figure courtesy of ITT McDonnell & Miller.

HOFFMAN SERIES 50 FLOAT AND THERMOSTATIC TRAPS
MODELS "F", "F&T", "T", "A", "V", "M"



Service Pkg. No.	Part No.	Size, Inches	Pressure, PSI
1-to-5-#53	36-16193	¾	15#
1-to-5-#54	36-16194	1	15#
1-to-5-#56	36-16198	1¼	15#
1-to-5-#57	36-12594	1½	15#
1-to-5-#58	36-16202	2	15#
1-to-5-#540	36-16195	¾ & 1	30#
1-to-5-#560	36-16199	1 & 1¼	30#
1-to-5-#580	36-16203	1½	30#
1-to-5-#541	36-16196	¾ & 1	60#
1-to-5-#561	36-16200	1¼	60#
1-to-5-#581	36-16204	1½	60#
1-to-5-#542	36-16197	¾ & 1	125#
1-to-5-#562	36-16201	1 & 1¼	125#
1-to-5-#582	36-16205	1½	125#

Service packages of complete cover assembly consists of

ITEM 1 Thermostat assembly

ITEM 2 Float lever and valve assembly (float lever, aligning screw and lockwasher, valve pin and cotter pin, valve seat, seat yoke and gasket spring)

ITEM 3 Float ball assembly (float ball and stc ¼-20-5/16" round head screw)

ITEM 4 Cover gasket

ITEM 5 Cover casting and gasket

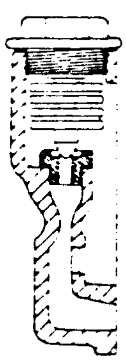
Trap No.	Item 2 Part No.	Item 3 Part No.	Item 4 Part No.	Item 5 Part No.
53F-FT	36-15476	35-11443	35-11447	36-16300
54F-FT	36-15477	35-11450	35-11447	36-16301
56F-FT	36-15480	35-11773	35-12046	36-16305
57F-FT	36-15484	35-12529	35-20230	36-16309
58F-FT	36-15485	35-10992	35-20233	36-16310
540F-FT	36-15475	35-11450	35-11447	36-16302
541F-FT	36-55476	35-11450	35-11447	36-16303
542F-FT	36-15479	35-11450	35-11447	36-16304
560F-FT	36-15481	35-11773	35-12046	36-16306
561F-FT	36-15482	35-11773	35-12046	36-16307
562F-FT	36-15483	35-11773	35-12046	36-16308
580F-FT	36-15486	35-10992	35-20233	36-16311
581F-FT	36-15487	35-10992	35-20233	36-16312
582F-FT	36-15488	35-10992	35-20233	36-16313

ITEM 1 Thermostat Assembly

15#-30#-60#	36-12589
125#	36-12590

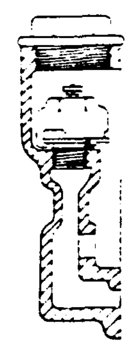
NOTE:
ITEMS 3 and 4 current for "T", "A", "V", "M" Traps

ITEMS 2 and 5 as originally furnished with "T", "A", "V", "M" Traps are obsolete. Use 1-to-5 Service Package as currently furnished on "F&T" Traps



DISCONTINUED MODEL 50 SERIES TRAP WITH THERMOSTAT AND SEAT INSTALLED IN COVER.

CURRENT THERMOSTAT ASSEMBLY ITEM 1 WILL FIT DISCONTINUED MODELS "T" AND "V".



HOFFMAN SERIES 50
FLOAT AND THERMOSTATIC TRAPS
MODELS "F", "F&T", "T", "A", "V", "M"

5

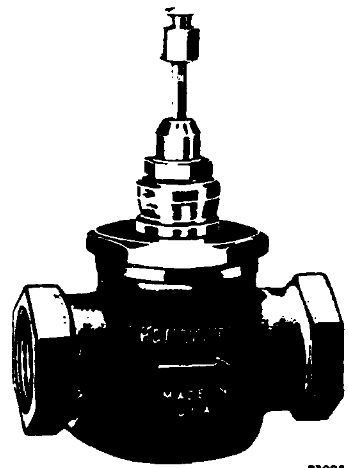
Figure courtesy of ITT McDonnell & Miller.

Honeywell

V5011A-E Single Seated Valves

GENERAL

V5011 single-seated, two-way, straight-through valves provide proportional control of steam, liquids, air, or other noncombustible gases in HVAC systems requiring tight shutoff. They are available in bronze bodies with screwed NPT end connections or cast iron bodies with flanged end connections.



FEATURES

- Direct or reverse acting.
- Stainless steel stem with removable composition disc and self-adjusting, spring-loaded Teflon packing.
- Bronze, brass, or stainless steel plugs provide equal percentage or linear flow characteristics.
- High pressure models available (V5011D or E).
- Stainless steel, metal-to-metal seating available in smaller valve sizes.
- Suitable for pneumatic (1/2- to 6-inch valve) or electric (1/2- to 4-inch valve) actuation with proper linkage.

SPECIFICATIONS

Models:
See Table 1.

Flow Characteristics:
Equal Percentage or Linear. See Table 1 and Figure 1.

Dimensions:
See Table 4 and Figures 2 through 4.

Close-off Ratings:
See Table 5 and Figure 8.

Valve Ratings:
See Table 2.

Controlled Mediums and Temperatures:
See Table 3.

Stem Travel:
1/2- to 3-in. valves: 3/4-in. (19 mm).
4-, 5-, and 6-in. valves: 1-1/2-in. (38 mm).

Trim Materials:
Stem: Stainless steel.
Packing: Teflon cone for 125 psi (860 kPa) flanged and 150 psi (1034 kPa) screwed valves, all sizes. Teflon V-ring for 250 psi (1725 kPa) valves, 1-1/2- to 6-inch size.
Disc: Removable composition.
Disc Holder:
Screwed bodies—brass.
Flanged bodies—cast iron.
Plug:
Screwed bodies with composition disc—contoured brass.
Screwed bodies with metal-to-metal seating—contoured stainless steel.
Flanged bodies—V-ported, skirt guided bronze.
Seat:
Screwed bodies—brass (replaceable, screwed into body).
Screwed bodies, metal-to-metal-stainless steel (recommend replacing valve).
Flanged bodies—bronze (replaceable, screwed into body).

Valve Actuators:
The V5011 valves require either MP953 actuators or electric/electronic Modutrol motors as listed in Table 6. Refer to Fig. 5, 6, and 7 for actuator dimensions.

Rev. 10-84

Form No 77-5315
Commercial Bldg Group
MLF TAB: II. D. 2.

Figure courtesy of Honeywell, Inc.

Accessories:

Packing Conversion Kits (for converting to high pressure applications):

14002920-001 Rubber V-ring for 1/2- to 1-1/4-inch valves (1/4-inch diameter stem).

14002920-002 Teflon V-ring for 1-1/2- to 3-inch valves (3/8-inch diameter stem).

When Ordering, Specify:

1. Model number, size, and direct or reverse acting.
2. Accessories.
3. Actuator and linkage (refer to Valve/Actuator Selection, Table 6).

Table 1. V5011 Model Descriptions and Body Specifications.

Model Number and Plug Characteristic	Action ⚠	End Connections	Body Size in Inches	Capacity Index (C_v)	Nominal Body Rating Pressure psi (kPa)	Nominal Body Rating Temperature F (C)
V5011A Equal Percentage and V5011C Linear	Direct	Screwed	1/2	0.4, 0.63, 1.0, 1.6, 2.5, 4.0	150 (1034) or 200 (1379)	366 (186) or 150 (66)
			3/4	6.3		
			1	10.0		
			1-1/4	16		
			1-1/2	25		
			2	40		
			2-1/2	63		
			3	100		
V5011A Equal Percentage	Direct	Flanged	2-1/2, or 3	63; 2-1/2 in. 100; 3 in.	125 (860) or 175 (1207)	353 (178) or 150 (66)
V5011D Equal Percentage					250 (1725) or 400 (2758)	400 (204) or 150 (66)
V5011A Equal Percentage	Direct	Flanged	4, 5, or 6	160; 4 in.	125 (860) or 175 (1207)	353 (178) or 150 (66)
V5011B Equal Percentage	Reverse			250; 5 in.		
V5011D Equal Percentage	Direct			360; 6 in.	250 (1725) or 400 (275)	400 (204) or 150 (66)
V5011E Equal Percentage	Reverse					

⚠ Direct: stem down to close.
Reverse: stem up to close.

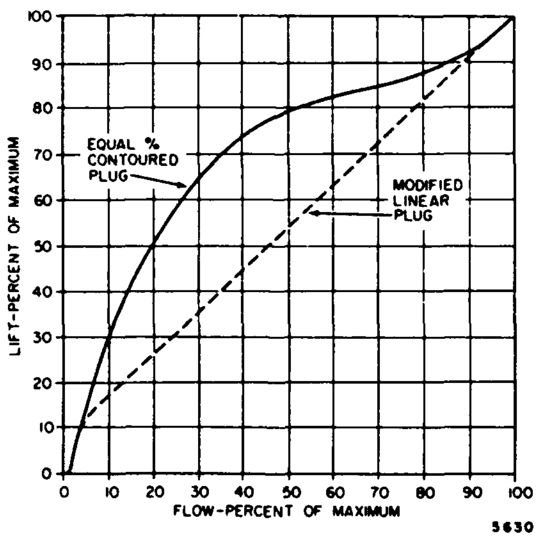


Fig. 1. V5011 Average Flow Characteristics.

Table 2. Valve Ratings. [1]

Body	Screwed, cast-bronze 150 psi at 366F max. (1034 kPa at 185C). 200 psi at 150F max. water (1379 kPa at 66C). [3] Flanged, cast iron 125 psi at 353F max. (860 kPa at 178C) or 175 psi at 150F max. (1207 kPa at 66C). 250 psi at 400F max. (1725 kPa at 204C) or 400 psi at 150F max. (2758 kPa at 66C).		
Max. Pressure Differential for Normal Life of Trim	Composition Discs	Water	Proportional, 25 psi (170 kPa)
			2-Position, 50 psi (345 kPa)
		Steam (A, B, & C) only)	Proportional, 35 psi (240 kPa)
			2-Position, 70 psi (480 kPa)
	Metal-to-Metal Seats	Steam only	100 psi (690 kPa)
Max. Pressure Differential for Quiet Water Service	20 psi (140 kPa)		
Max. Pressure Differential for Close-Off	Refer to Fig. 8 and Table 5.		
Teflon Cone Packing (V5011A & C)	Water [2]	150 psi at 250F max. (1034 kPa at 121C); 40F min. (4C)	
	Steam	100 psi at 337F max. (680 kPa at 169C)	
Teflon V-ring Packing, 3/8-in. Stem (V5011D & E and 14002920-002 Kit)	Water [2]	250 psi at 250F max. (1725 kPa at 121C); 40F (4C)	
Rubber V-ring Packing, 1/4-in. Stem (14002920-001 Kit)	Water		

[1] For high fluid temperatures, the valve and/or piping should be insulated to prevent ambient temperatures from exceeding ratings at the actuator location.

[2] Maximum temperature differential in alternate hot-cold water use, 140F (60C).

[3] Modified with high pressure packing kit.

Table 3. Recommended Controlled Mediums and Temperatures.

Model Number	End Connections	Recommended Controlled Medium	Temperature Range F (C) (Composition Disc)
V5011A & D	Screwed	Water	35 to 200 (2 to 99)
		Water	115 to 275 (46 to 135)
	Flanged	Water	35 to 275 (2 to 135)
V5011B	Flanged	Water	35 to 275 (2 to 135)
V5011C*	Screwed	Steam	115 to 275 (46 to 135)
			275 to 425 (135 to 218)
V5011D	Flanged	Water	35 to 275 (2 to 135)
V5011E	Flanged	Water	35 to 275 (2 to 135)

*Metal-to-metal seats available in 1/2 to 1-1/2 inch valve sizes.

Figure courtesy of Honeywell, Inc.

Table 4. V5011A-E Approximate Dimensions in Inches (Millimeters). Refer to Figures 2, 3, and 4.

Body Style and Figure Reference	Valve Size (in.)	A	B	C	D	E	F	G	No. of Flange Bolt Holes
V5011A & C Screwed, Direct Body (Fig. 2)	1/2	1-3/4 (44)	1-3/4 (44)	3-3/8 (86)	—	1-13/16 (46)	1-5/8 (41)	4-3/4	—
	3/4	1-5/8 (41)	1-3/4 (44)	3-1/2 (89)	—	1-13/16 (46)	1-5/8 (41)	4-3/4	—
	1	1-3/4 (44)	1-5/8 (41)	4-3/8 (111)	—	1-15/16 (49)	1-3/4 (44)	4-7/8	—
	1-1/4	1-15/16 (49)	1-1/2 (38)	5 (126)	—	2-9/16 (65)	1-15/16 (49)	5-1/16	—
	1-1/2	2-3/4 (70)	1-3/8 (35)	5-3/4 (146)	—	3-9/16 (90)	2-11/16 (68)	5-3/16	—
	2	3 (76)	2 (51)	5-3/4 (146)	—	3-9/16 (84)	2-5/16 (58)	5-17/16	—
	2-1/2	2-9/16 (65)	2-3/8 (60)	7-1/2 (194)	—	4-3/8 (104)	3-1/16 (77)	5-11/16	—
	3	3 (76)	2-3/8 (60)	8-7/8 (226)	—	4-15/16 (125)	3-5/8 (92)	6-1/8	—
V5011A Flanged, Direct Body (Fig. 2)	2-1/2	4-13/16 (122)	4 (102)	9-1/2 (241)	7 (178)	2-1/2 (19)	3/4 (63)	5-1/2 (140)	4
	3	5-3/8 (136)	4-5/8 (117)	11 (279)	7-1/2 (190)	3 (76)	3/4 (19)	6 (152)	4
	4	7-9/16 (192)	5-3/16 (132)	13 (330)	9 (229)	4 (102)	3/4 (19)	7-1/2 (190)	8
	5	7 (178)	6-1/8 (155)	15 (381)	10 (254)	5 (127)	7/8 (22)	8-1/2 (215)	8
	6	8 (203)	7-1/16 (179)	16-1/2 (419)	11 (279)	6 (152)	7/8 (22)	9-1/2 (241)	8
V5011B Flanged, Reverse Body (Fig. 3)	4	4-11/16 (119)	8-1/16 (205)	13 (330)	9 (229)	4 (102)	3/4 (19)	7-1/2 (190)	8
	5	5-5/8 (143)	7-1/2 (190)	15 (381)	10 (254)	5 (127)	7/8 (22)	8-1/2 (215)	8
	6	6-9/16 (167)	8-1/2 (216)	16-1/2 (419)	11 (279)	6 (152)	7/8 (22)	9-1/2 (241)	8
V5011D Flanged, Direct Body (Fig. 3)	2-1/2	4-13/16 (122)	3-3/4 (95)	11-1/2 (292)	7-1/2 (178)	2-1/2 (63)	7/8 (22)	5-7/8 (149)	8
	3	5-3/8 (136)	4-1/4 (108)	12-1/2 (317)	8-1/4 (209)	3 (76)		6-5/8 (168)	8
	4	7-9/16 (192)	5 (127)	14-1/2 (368)	10 (254)	4 (102)		7-7/8 (200)	8
	5	7 (178)	5-1/2 (140)	16-3/4 (425)	11 (279)	5 (127)		9-1/4 (235)	8
	6	8 (203)	6-1/4 (159)	18-5/8 (473)	12-1/2 (318)	6 (152)	7/8 (22)	10-5/8 (270)	12
V5011E Flanged, Reverse Body (Fig. 4)	4	4-3/4 (120)	7-5/16 (186)	14-1/2 (368)	10 (254)	4 (102)	7/8 (22)	7-7/8 (200)	8
	5	5-3/4 (146)	6-3/4 ([illegible])	16-3/4 (425)	11 (279)	5 (127)		9-1/4 (235)	8
	6	6-11/16 (170)	[illegible] (200)	18-5/8 (473)	12-1/2 (318)	6 (152)	7/8 (22)	10-5/8 (270)	12

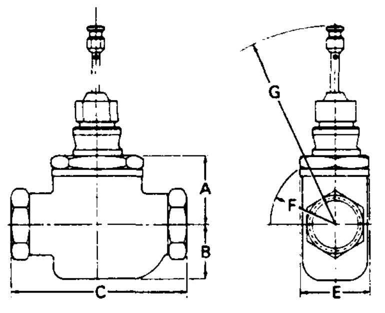


Fig. 2. V5011A and C Screwed, Direct Acting Body Dimensions (Refer to Table 4).

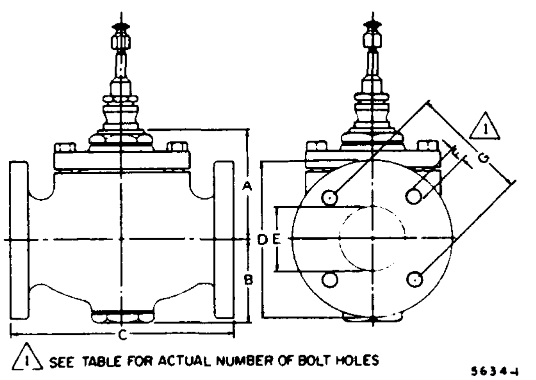


Fig. 3. V5011A and D Flanged Body Dimensions (Refer to Table 4).

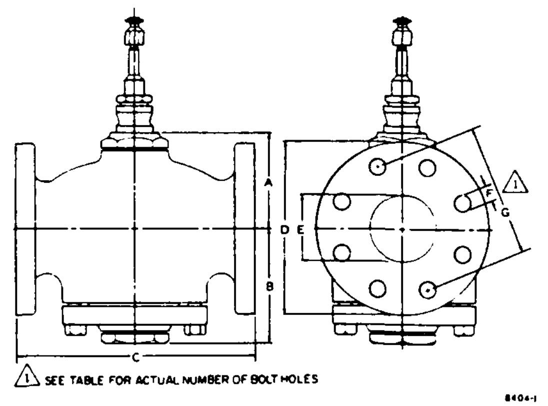


Fig. 4. V5011B and E Flanged Body Dimensions (Refer to Table 4).

Figure courtesy of Honeywell, Inc.

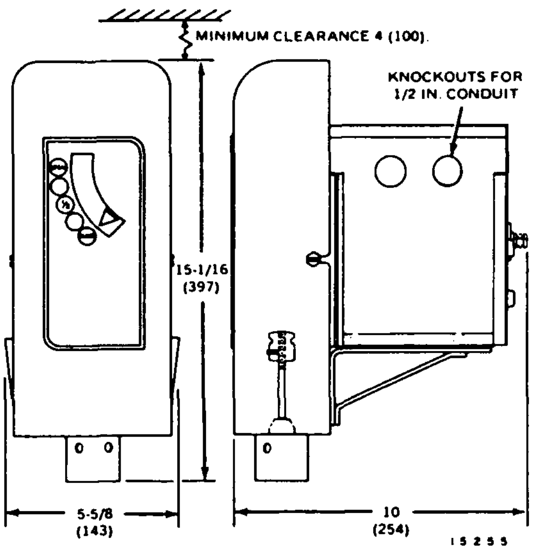
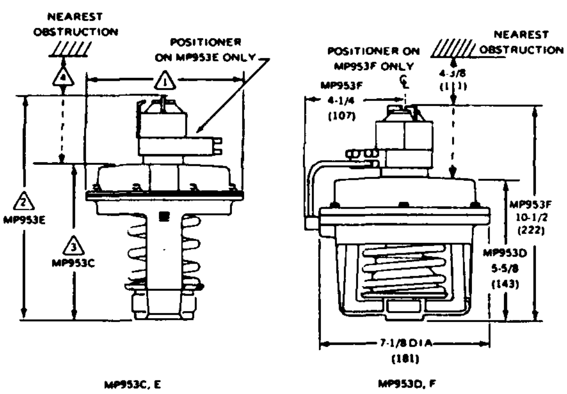


Fig. 5. Approximate Dimensions in Inches (Millimeters) of Typical Electric/Electronic Actuator with Q601 Linkage (M644 Shown).



OPERATOR SIZE NOMINAL DIA	1	2	3	4
5-INCH	5-1/8 (130)	9-1/4 (235)	4-5/8 (117)	4-3/8 (111)
8-INCH	8-1/4 (210)	11-1/8 (283)	6-1/2 (165)	5-3/8 (137)
13-INCH	13-1/2 (343)	18-1/8 (460)	10 (254)	7-11/16 (195)

Fig. 6. MP953C to F Dimensions in Inches (Millimeters).

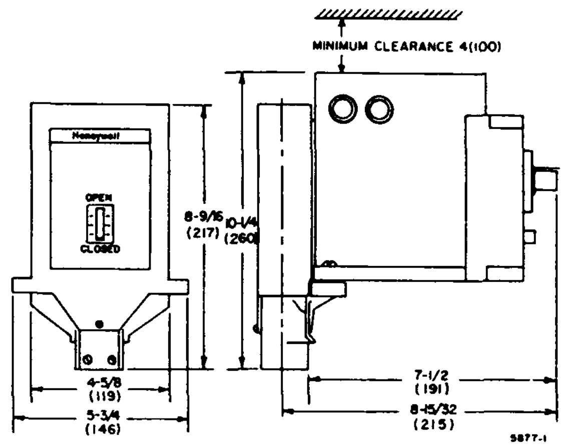


Fig. 7. Approximate Dimensions of Q618 Linkage with Modutrol Motor in Inches (Millimeters). (Note: Motor shown is representative, other motors may vary in size.)

Table 5. Close-Off Ratings for V5011A-E with Electric Actuators.

Model Number	Close-Off Ratings psi (kPa) Linkage Seal-Off Force 160 lb (711 N) ⚠1	80 lb (356 N) ⚠2	C_v	Body Size in Inches
V5011A & C Screwed Connections	150 (1034)	150 (1034)	0.40	1/2
			0.63	
			1.0	
			1.6	
			2.5	
			4.0	
	150 (1034)	122 (840)	6.3	3/4
	150 (1034)	106 (731)	10.0	1
	141 (970)	60 (414)	16.0	1-1/4
	91 (627)	39 (269)	25.0	1-1/2
	55 (379)	22 (152)	40.0	2
	32 (221)	12 (83)	63.0	2-1/2
	20 (138)	8 (55)	100.0	3
V5011A & D Flanged	26 (179)	10 (69)	63.0	2-1/2
	20 (138)	7 (48)	100.0	3
	10 (69)	—	160.0	4
	6 (41)	—	250.0	5
	4 (28)	—	360.0	6
V5011B & E Flanged	10 (69)	—	160.0	4
	6 (41)	—	250.0	5
	4 (28)	—	360.0	6

⚠1 160 lb—Q618A (160 lb model); Q601D, E, J, K; Q455B, C, D.

⚠2 80 lb—Q618A (80 lb model); Q601F, G, H, L, M; Q455A, E, F, G.

Figure courtesy of Honeywell, Inc.

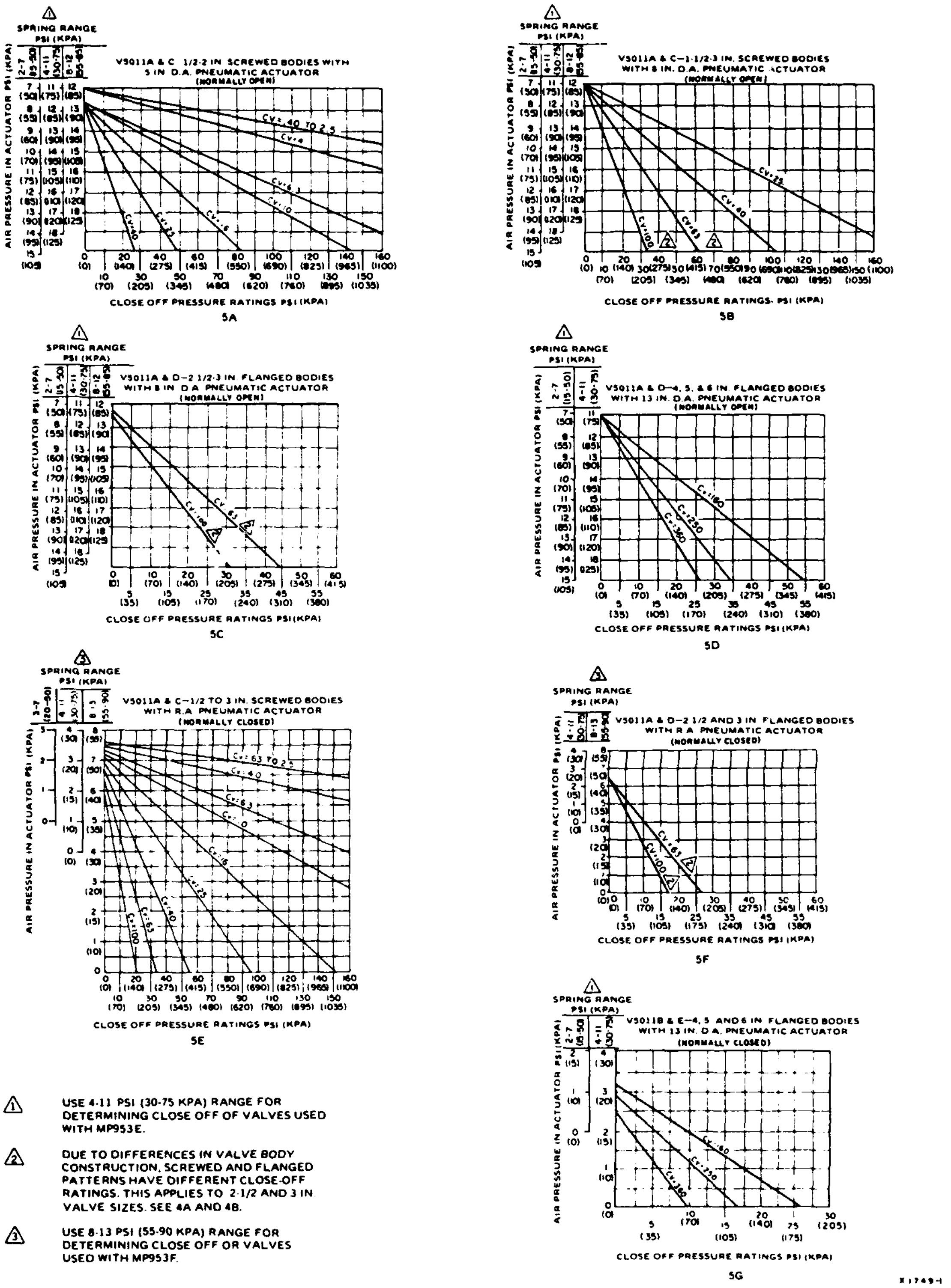


Fig. 8. Close-Off Pressures at Various Control Air Pressures for V5011A-E Single-Seated Valves and MP953 Pneumatic Actuators.

Figure courtesy of Honeywell, Inc.

Table 6. V5011 Valve/Actuator Selection.

Valve	Size (Inches)	C_v	(1) Pneumatic Actuators	(2) Electric Actuators: Two-Position or Floating Non-Spring Return	Two-Position Spring Return	Proportional Non-Spring Return	Proportional Spring Return	(2) Electronic Actuator: Proportional Non-Spring Return	Proportional Spring Return
V5011A	1/2 NPT	.63, 1.0, 1.6, 2.5, 4.0	A1, C1 A2, C2 B1, D1	E or F	H or I	J, L, or T	M, N, or U	Q or R	S
	3/4	6.3							
	1	10							
	1-1/4	16							
	1-1/2	25							
	2	40	A1, C1						
	2-1/2	63							
	3 NPT	100	A2, C2 B1, D1	E or F	H or I	J, L or T	M, N or U	Q or R	S
	2-1/2 FLG	63	A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
	3	100	A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
	4	160	A3, C3	F	•	K	•	•	•
	5	250		F	•	K	•	•	•
	6 FLG	360	A3, C3	F	•	K	•	•	•
V5011B	4 FLG	160	A3, C3	F	•	K	•	•	•
	5	250		F	•	K	•	•	•
	6 FLG	360	A3, C3	F	•	K	•	•	•
V5011C	1/2 NPT	.40, .63, 1.0, 1.6, 2.5, 4.0	A1, C1 A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
	3/4	6.3							
	1	10							
	1-1/4	16							
	1-1/2	25							
	2	40	A1, C1						
	2-1/2	63							
	3 NPT	100	A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
V5011D	2-1/2 FLG	63	A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
	3	100	A2, C2 B1, D1	E	H or I	J, L or T	M, N or U	Q or R	S
	4	160	A3, C3	F	•	K	•	•	•
	5	250		F	•	K	•	•	•
	6 FLG	360	A3, C3	F	•	K	•	•	•
V5011E	4 FLG	160	A3, C3	F	•	K	•	•	•
	5	250		F	•	K	•	•	•
	6 FLG	360	A3, C3	F	•	K	•	•	•

•Not recommended for tight close-off. Use pneumatic actuator.

NOTES:

(1) The MP953C-F are rolling type diaphragm actuators which provide proportional control of V5011 valves.

A1—MP953E D.A. 5 in. dia. with positioner.
A2—MP953E D.A. 8 in. dia. with positioner.
A3—MP953E D.A. 13 in. dia. with positioner.

B1—MP953F R.A. 7-1/8 in. dia. with positioner.

C1—MP953C D.A. 5 in. dia. without positioner.
C2—MP953C D.A. 8 in. dia. without positioner.
C3—MP953C D.A. 13 in. dia. without positioner.

D1—MP953D R.A. 7-1/8 in. dia. without positioner.

(2) Example Linkages:
Q601E1000—160 lb seal-off force.
Q618A1024—160 lb seal-off force.
Q618A1032— 80 lb seal-off force.

Letter Designation	Use Motor Similar to:	With Linkage Similar to:
E	M644A	Q618A1024
F	M644C	Q601E1000
H	M845A	Q618A1032
I	M845E	Q618A1032
J	M944A	Q618A1024
K	M944C	Q601E1000
L	M934A	Q618A1032
M	M945A	Q618A1032
N	M945F	Q618A1032
Q	M734H, J	Q618A1032
R	M744A	Q618A1024
S	M745A-F	Q618A1032
T	M954A, D	Q618A1024
U	M955A, C	Q618A1032

Figure courtesy of Honeywell, Inc.

TYPICAL OPERATION

In a normally open valve assembly application (direct acting valve with a direct acting pneumatic actuator), an increase in branch line pressure from a sensor or controller moves the valve stem toward the closed position.

In a normally closed valve assembly (reverse acting valve with a direct acting pneumatic actuator), an increase in branch line pressure moves the valve stem toward the open position.

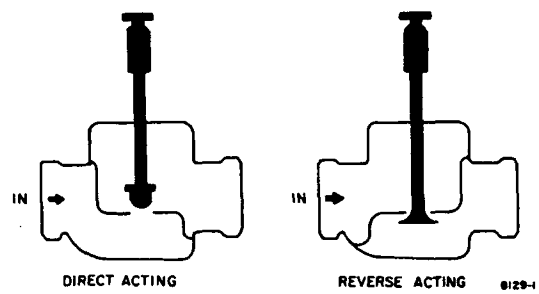


Fig. 9. Typical Operation.

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MP953C-F Pneumatic Actuators for V5011 & V5013 Valves

MP953C

MP953E

GENERAL

MP953 Pneumatic Actuators operate V5011 and V5013 Valves to provide proportional control of steam or hot and cold liquids of HVAC systems.

FEATURES

- Rolling diaphragm for long life and low hysteresis
- Easily attached to valve
- May be installed after piping valve
- Slide lock feature permits simple engagement to valve stem
- Direct- or reverse-action control
- Models available with positive positioning relay

77-3001

Figure courtesy of Honeywell, Inc.

DESCRIPTION

The MP953 Pneumatic Actuators operate V5011 and V5013 Valves to provide proportional control of steam or hot and cold liquids of HVAC systems.

SPECIFICATIONS

Models:
See Table below

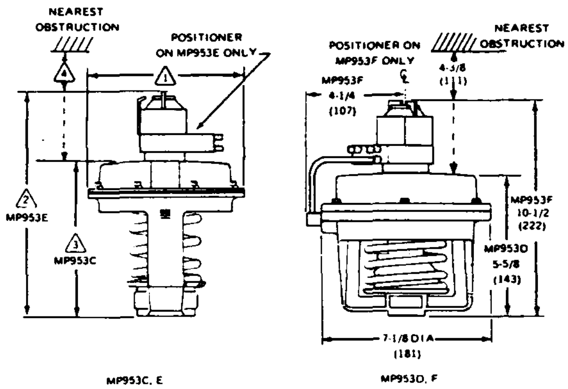
Maximum Diaphragm Temperature:
160F (71C) standard
250F (121C) high-temperature model (MP953D only)

Maximum Safe Operating Pressure:
25 psi (172 kPa)

Accessories:
Position Indicator for:
- 5-inch (127 mm) dia: 316028A
- 7-inch (178 mm) dia: 316035A
- 8-inch (203 mm) dia: 316037A
- 13-inch (330 mm) dia: 316036A

Valve Bonnet Extension Kit: 14000501-001 (separates actuator 2-1/2 inches [64 mm] from valve for high-temperature applications)
Corrosion-Resistant Spray: CCT 3858

Dimensions:



OPERATOR SIZE NOMINAL DIA	1	2	3	4
5-INCH	5-1/8 (130)	9-1/4 (235)	4-5/8 (117)	4-3/8 (111)
8-INCH	8-1/4 (210)	11-1/8 (283)	6-1/2 (165)	5-3/8 (137)
13-INCH	13-1/2 (343)	18-1/8 (460)	10 (254)	7-11/16 (195)

18770 1

MP953A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

MP953C, D, E, and F

Model	Action	Positive Positioner	√	Diaphragm Dia. in Inches (mm)	Effective Area of Diaphragm in Square Inches	Stroke in Inches (mm)	Operating Range in psi (kPa)
MP953C	Direct	No		5 (130)	11	1/2 (12) or 3/4 (19)	2 to 7 (12 to 50) or
				8 (203)	33	3/4 (19) or 1-1/2 (38)	4 to 11 (30 to 75) or 8 to 12 (55 to 85)
				13 (330)	99	1-1/2 (38)	4 to 11 (30 to 75) or 2 to 7 (12 to 50)
MP953D	Reverse	No		7 (180)	21.6	1/2 (12) or 3/4 (19)	3 to 7 (20 to 50) or 4 to 11 (30 to 75) or 8 to 13 (55 to 90)
MP953E	Direct	Yes		5 (130)	11	3/4 (19)	△1 3, 5, or 10 (20, 35, or 70)
				8 (203)	33	3/4 (19) or 1-1/2 (38)	
				13 (330)	99	1-1/2 (38)	
MP953F	Reverse	Yes		7 (180)	21.6	3/4 (19)	Same as MP953E

△1 Start point is adjustable from 1-1/2 (10) to 13 psi (90 kPa) in 1/4 psi (1-1/2 kPa) increments.

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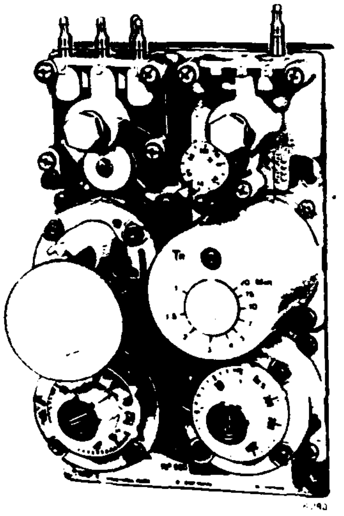
RP920A-D Modular Pneumatic Controller



GENERAL

The RP920 Modular Pneumatic Controllers, in conjunction with remote sensors, provide proportional or proportional plus integral control of temperature, humidity, pressure, or dewpoint in heating and air-conditioning systems.

FEATURES

- Proportional plus integral control minimizes offset.
- Miniature diaphragm technology provides high degree of accuracy and reliability.
- Field adjustable compensation start point.
- Local or remote setpoint field optional.
- Integral action cut-off provides trouble-free automatic startup.
- Transparent cover (optional) provides protection while allowing easy reading of settings and gages.
- Corrosion resistant construction.

74-5576

Figure courtesy of Honeywell, Inc.

DESCRIPTION

The RP920 Modular Pneumatic Controllers, in conjunction with remote sensors, provide proportional or proportional plus integral control of temperature, humidity, pressure, or dewpoint in heating and air-conditioning systems.

SPECIFICATIONS

Models:

☐ RP920A: Single Input Proportional Controller.
☐ RP920B: Dual Input Proportional Controller.
☐ RP920C: Single Input Proportional plus Integral Controller.
☐ RP920D: Dual Input Proportional plus Integral Controller.

All models available Direct or Reverse Acting.

All models available with Control Point Adjustment (CPA).

Dimensions:

See Figure 1.

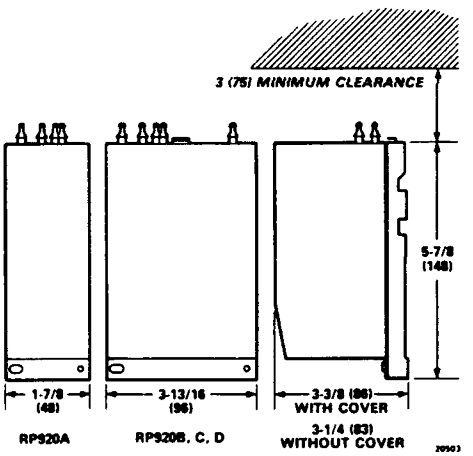


Fig. 1. RP920 Dimensions in Inches (Millimeters).

Air Connections:

Combination 5/32-inch (4 mm) and 1/4-inch (6 mm) push-on barb.

Main Air Supply:

18 psi (125 kPa) minimum.

Maximum Safe Air Pressure:

30 psi (200 kPa).

Input Signals:

3 to 15 psi (21 to 104 kPa).

Output Signal:

3 to 13 psi (21 to 91 kPa).

Air Consumption:

Add sensor consumption for total. Values valid for 18 psi MLP and 8.5 psi BLP (125 kPa MLP and 58 kPa BLP).

RP920A and C: 0.021 scfm (10.0 mℓ/s).

RP920B and D: 0.046 scfm (21.7 mℓ/s).

Normal Sensor: 0.019 scfm (9.0 mℓ/s) depending on sensor selected.

Air Capacity:

0.07 scfm (33.0 mℓ/s) with 1 psi (6.9 kPa) pressure difference and 18 psi (124.1 kPa) MLP.

Proportional Band:

2.5 to 50%, field adjustable.

Authority (RP920B and D only):

5 to 300% of primary sensor span.

Compensation Start Point (RP920B and D Only):

0 to 100% of compensation sensor span.

Control Point Adjustment (Orderable Option):

± 15% of primary sensor span with 3 to 15 psi (20 to 100 kPa) input.

Remote Setpoint (Field Option):

0 to 100% of primary sensor span with 3 to 15 psi (20 to 100 kPa) input.

Integral Reset Time:

0.5 to 20 minutes, field adjustable.

Ambient Temperature:

40 to 130 F (5 to 55 C).

Accessories:

1. Barb fitting 14003755-001 for port 4, 6, 7, or 8 if connection required.
2. Gages.
3. Remote setpoint device, SP970 or equivalent.
4. Cover RP920A: 43188057-001.
5. Cover RP920B, C, D: 43188123-001.
6. Static Pressure Setpoint Scales 14004267-002. (Commonly used scales for temperature, dewpoint, and relative humidity are included with the RP920).
7. Rail Mounting Bag Assembly 14004322-001 (25 sets per bag assembly).

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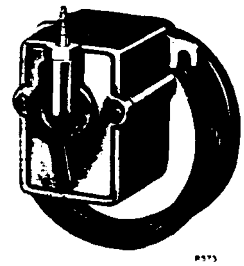
LP914A and LP915A Pneumatic Temperature Sensors

LP914



LP915

GENERAL

The LP914A and LP915A Sensors are proportional-type temperature sensors used with a pneumatic receiver controller for control of pneumatic valves and damper actuators in fanroom applications. The LP915A is a duct-mounted, liquid-filled, averaging type sensor. The rod and tube insertion element of the LP914A can be duct-, well-, or through-the-wall mounted.

FEATURES

- May be used with a calibrated gage for continuous temperature indication.

 77-9268

Figure courtesy of Honeywell, Inc.

DESCRIPTION

The LP914A and LP915A Sensors are proportional-type temperature sensors used with a pneumatic receiver controller for control of pneumatic valves and damper actuators in fanroom applications. The LP915A is a duct-mounted, liquid-filled, averaging type sensor. The rod and tube insertion element of the LP914A can be duct-, well-, or through-the-wall mounted.

SPECIFICATIONS

Models:

☐ LP914A: Insertion element, direct acting.
☐ LP915A: Averaging element, direct acting.

Sensing Range:

Nonadjustable.

LP914A	LP915A
−40 to +160F (−40 to +71C)	0 to 200F
+40 to +240F (+5 to +115C)	(−18 to +93C)
−20 to +80F (−29 to +27C)	25 to 125F
+25 to +125F (−4 to +56C)	(−1 to 54C)

Maximum Safe Temperature at the Element:

LP914A: 265F (228.3C)
LP915A: 225F (118.2C)

Supply Air Pressure:

18 psi (124 kPa) nominal for both LP914A and LP915A.

Maximum Safe Air Pressure:

25 psi (172 kPa) for both LP914A and LP915A.

Pressure Output:

3 to 15 psi (21 to 103 kPa).

Air Consumption:

0.019 scfm (9.0 mℓ/s).

Air Connections:

Push-on combination barb connector for 5/32 in. (4 mm) and 1/4 in. (6 mm) O.D. tubing.

Mounting:

Duct-mounted, LP914A and LP915A.
Well-mounted, LP914A.
Through-the-wall mounted (up to 12 in. [304.8 mm] thick), LP914A.

Element (Type and Size):

LP914A: Rod and tube, 6 in. (152.4 mm) and 15 in. (381 mm) lengths for water and air.
LP915A: Liquid filled, 8 ft 8 in. (2.6 m) or 20 ft (6.1 m) averaging.

Dimensions:

See Figures 1 and 2.

Finish:

Gray styrene plastic cover, nonremovable, for LP914A; brass forging for LP915A.

Accessories Available:

Wells for LP914A only:
Copper: A Dimension:
315046A 15-3/18 (385 mm)
315046B 7-3/8 (187 mm)
Stainless Steel: A Dimension:
315904A 15-5/16 (389 mm)
315904B 7-5/16 (186 mm)
Averaging element clip 314439 for LP915A.

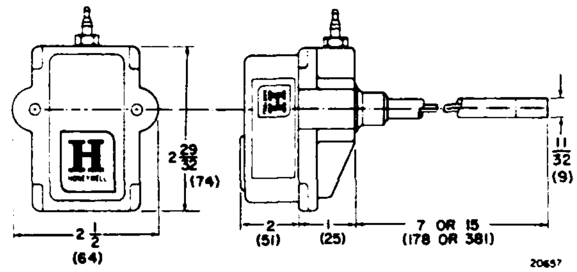


Fig. 1. LP914A Approximate Dimensions in Inches (Millimeters).

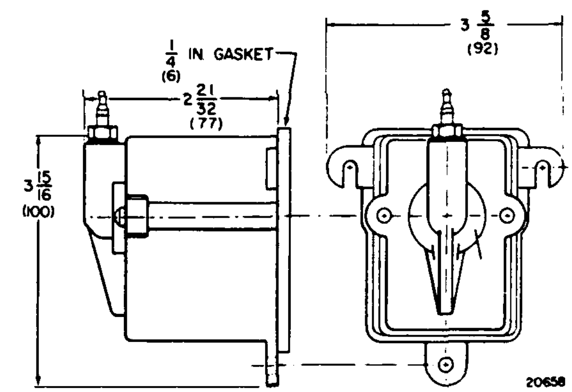


Fig. 2. LP915A Approximate Dimensions in Inches (Millimeters).

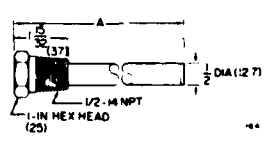


Fig. 3. Nominal Dimensions in Inches (Millimeters) of LP914A Wells.

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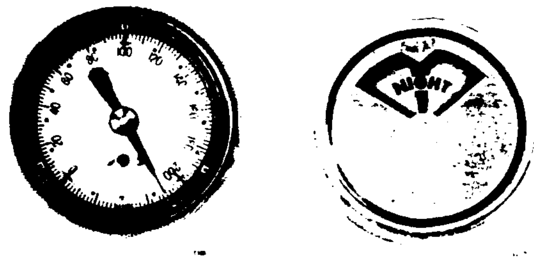
Pneumatic Indication, Receiver & Target Gages



GENERAL

Pneumatic gages provide continuous indication in a pneumatic control system. They are flush or stem mounted in the factory or field. The three gage types are applied as follows:

Indication gages indicate pneumatic system pressures such as main air, branch line, or compressor tank.

Receiver gages indicate sensor line values. These may be either the 3 to 15 psi (21 to 103 kPa) signal or its analog equivalent.

Target Gages indicate pneumatic control system status such as Day-Night, Summer-Winter, or Closed-Modulating-Open.

FEATURES

- High accuracy and dependability.
- Easily calibrated from the front.
- Scaleplates replaceable for 2-1/2 and 3-1/2 inch Receiver Gages.

 77-6091

Figure courtesy of Honeywell, Inc.

DESCRIPTION

Pneumatic Indication, Receiver, and Target Gages are accurate instruments providing continuous indication in a pneumatic control system. The gages are factory or field mounted.

SPECIFICATIONS

ALL GAGES

Pressure Range:
Indication gages: See Table 2.
Receiver gages: 3 to 15 psi (21 to 103 kPa).

Maximum Safe Pressure:
Indication gages: See Table 2.
Receiver gages: 25 psi (175 kPa).

Dimensions:
See Figures 1 and 2 and Table 1.

STEM-MOUNTED GAGES

Models:
Indication Gages: See Table 2.
Receiver Gages: 1-1/2 inch dial see Table 3 for ranges and model numbers.

Accuracy:
± 2% of scale range.

Mounting:
Back-connected stem.

Air Connection:
See Figure 1.

Replacement Crystal:
1-1/2 inch dial—Not available.
2 inch dial—Not available.
2-1/2 inch dial—802774.
3-1/2 inch dial—802775.

FLUSH-MOUNTED GAGES

Models:
Indication Gages: See Table 2.
Receiver Gages:
2-1/2 inch dial 14505895-001, -101.
3-1/2 inch dial 14505896-001, -101, and -201.
See Table 3 for ranges and part numbers of interchangeable scaleplates.

Accuracy:
Indication gages: ± 2% of scale range at 9 psi.
Receiver gages:
-001 suffix, ± 2% of scale range at 9 psi.
-101 suffix, ± 1% of scale range at 9 psi.
-201 suffix, ± 1/4% of scale range at 9 psi.

Mounting:
Flush mounted in panel up to 7/16 in. (11 mm) thick.

Air Connection:
See Figure 2.

Replacement Crystal:
1-1/2 inch dial—Not available.
2-1/2 inch dial—14505882-001.
3-1/2 inch dial—14505883-001.

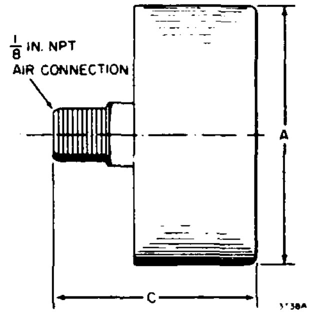


Fig. 1. Stem-Mounted Gage Approximate Dimensions. Refer to Table 1.

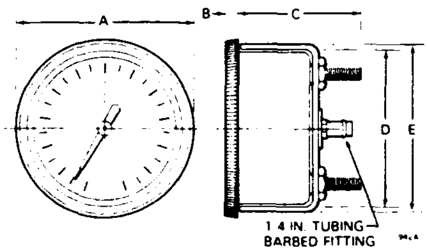


Fig. 2. Flush-Mounted Gage Approximate Dimensions. Refer to Table 1.

Table 1. Gage Dimensions in Inches (Millimeters). Refer to Figures 1 and 2.

Gage	A	B	C	D	E
2-1/2 (64)	3 (76)	7/32 (5.6)	1-7/8 (48)	2-19/32 (66)	2-3/4 (70)
3-1/2 (89)	4-1/8 (105)	5/16 (7.9)	1-7/8 (48)	3-21/32 (93)	3-7/8 (98)
1-1/2 (38)	1-11/16 (43)	—	1-21/32 (92)	—	—
Target	3 (76)	1/4 (6)	1-15/16 (49)	2-19/32 (66)	2-3/4 (70)

Figure courtesy of Honeywell, Inc.

Table 2. Indication Gage Ranges and Models.

Units	Range	Stem-Mounted 1-1/2 in. Dial	Stem-Mounted 2 in. Dial	Flush-Mounted 2-1/2 in. Dial	Flush-Mounted 3-1/2 in. Dial	Maximum Safe Pressure
psi	0 to 30	305965	305914 ⚠1	804191B	804190B	32 psi
	0 to 60	—	—	804191C	804190C	65 psi
	0 to 160	—	305917 ⚠1 ⚠2	804191E	804190E	170 psi

⚠1 Used on PP902.

⚠2 1/4 inch MPT Connection.

Replaceable Scaleplate:

Figure 3 shows a typical scaleplate.

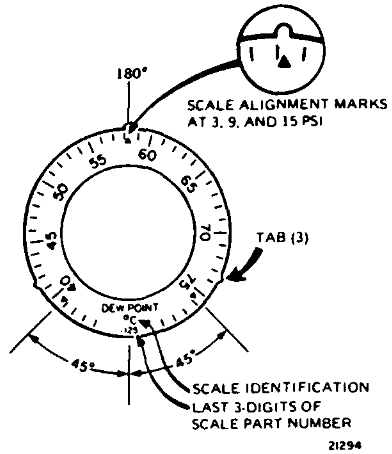


Fig. 3. Typical Receiver Gage Replaceable Scaleplate.

Table 3. Receiver Gage and Scaleplate Ranges and Models.

Units	Range	Stem-Mounted Gages 1-1/2 in. (38 mm) Dial	Scaleplates 14505846- 2-1/2 in. (64 mm) Dial	Scaleplates 14505846- 3-1/2 in. (89 mm) Dial	Scale Identification
Degrees Fahrenheit	50 to 100	305972	005	105	°F
	40 to 240	305931	003	103	
	25 to 125	14000786-001	004	104	
	0 to 200	305930	002	102	
	-20 to 80	305986	006	106	
	-40 to 160	305929	001	101	
Degrees Celsius	10 to 38	305973	010	110	°C
	5 to 115	305934	009	109	
	-5 to 55	14000786-002	011	111	
	-18 to 93	305933	008	108	
	-30 to 30	305987	012	112	
	-40 to 70	305932	007	107	
Inches H_2O	-1 to 1	305615	—	—	In. H_2O
	0 to 2	305616	013	113	
	1 to 3	305617	014	114	
	2 to 4	305618	015	115	
	3 to 5	305619	016	116	
	4 to 6	305620	017	117	
	0 to 5	—	018	118	
Millimeters H_2O	-25 to 25	305621	—	—	mm H_2O
	0 to 50	305622	020	112	
	25 to 75	305623	—	—	
	50 to 100	305624	—	—	
	75 to 125	305625	—	—	
	100 to 150	305626	019	119	
psi	0 to 50	—	024	124	PSIG
	0 to 20	—	023	123	
	3 to 15	—	022	122	
kPa	20 to 100	—	031	131	kPa
Percent Relative Humidity	65 to 95	14000786-004	030	130	% RH
	30 to 80	—	029	129	
	15 to 75	14000786-003	027	127	
	15 to 85	14000786-005	028	128	
Dewpoint F	40 to 75	305988	025	125	Dewpoint °F
Dewpoint C	5 to 25	305989	026	126	Dewpoint °C
Percent	0 to 100	—	021	121	%
Air Velocity Ft/Min	150 to 600	—	032	132	Ft/Min
	300 to 1500	—	033	133	100 Ft/Min
	500 to 2500	—	034	134	Ft/Min

Figure courtesy of Honeywell, Inc.

TARGET GAGES

Models:
See Tabel 4.

Dimensions:
See Figure 2 and Table 1.

Maximum Safe Pressure:
25 psi (172 kPa).

Gage Accuracy:
±2%.

Degrees Travel:
270 degrees with 108-degree viewing window.

Mounting:
Flush.

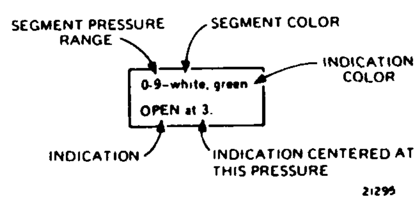
Air Connection:
1/4-inch (6 mm) barbed fitting.

Table 4. Target Gage Specifications.

Number	Indication	Range psi [1]	Gage Calibration in psi [1] [2]		
317086E	DAY-NIGHT	12.5-18.5	12.5-13.5—white, black DAY at 13. [3]	17.5-18.5—black, black NIGHT at 18. [3]	
317086G	DAY-NIGHT	0-20	0-9—white, black DAY at 3.	9-20—black, white NIGHT at 18.	
317086K	DAY-WARM UP-NIGHT	0-22.5	0-14.5— white, black DAY at 13. [3]	14.5-18.5—red, black WARM UP at 16. [3]	18.5-22.5—black, black NIGHT at 21. [3]
317086L	OCCUPIED-UNOCCUPIED	0-18	0-9—white, black OCCUPIED at 3.	9-18—black, white UNOCCUPIED at 15.	
317086F	SUMMER-WINTER	12.5-18.5	12.5-13.5—green, black SUMMER at 13. [3]	17.5-18.5—white, black WINTER at 18. [3]	
317086H	SUMMER-WINTER	0-20	0-9—green, black SUMMER at 3.	9-20—white, black WINTER at 18.	
317086M	WINTER-SUMMER	0-18	0-9—white, black WINTER at 3.	9-18—green, white SUMMER at 15.	
317086A	OFF-ON	0-18	0-9—white, green OFF at 3.	9-18—green, white ON at 15.	
317086P	ON-OFF	0-18	0-9—green, white ON at 3.	9-18—white, green OFF at 15.	
317086B	HIGH-ALARM	0-18	0-9—white.	9-18—red, white HIGH at 18.	
317086C	LOW-ALARM	0-20	0-9—red, white LOW at 1.5.	9-20—white.	
317086D	HIGH & LOW ALARM	0-19.5	0-3—red, white LOW at 1.5.	3-13—white.	13-19.5—red, white HIGH at 18.
317086J	OPEN-CLOSED	0-20	0-9—white, green OPEN at 3.	9-20—green, white CLOSED at 18.	
317086N	CLOSED-OPEN	0-18	0-9—green, white CLOSED at 3.	9-18—white, green OPEN at 15.	
317086R	CLOSED-MODULATING-OPEN	0-18	0-13—green, white vertical CLOSED at 1.5.	3-13—green, white MODULATING at 8.	13-18—white, black OPEN at 17.

[1] To convert psi to approximate kPa, multiply psi by 7.

[2]



[3] Light gray beige, behind lettering.

Honeywell

77-6091
Commercial Bldg Group
MLF TAB IV C 3

In the USA: Honeywell Plaza, Minneapolis, Minnesota 55408
In Canada: Scarborough, Ontario
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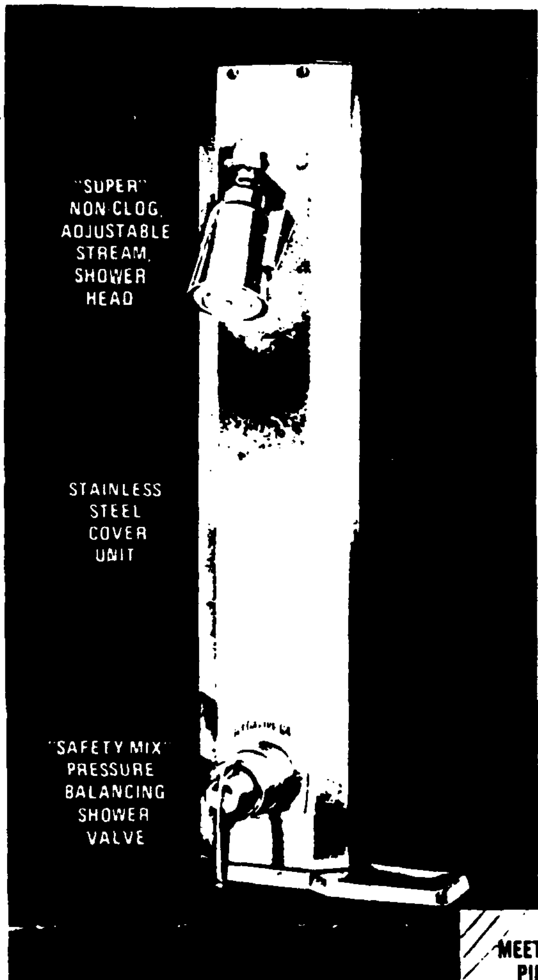
Printed In USA

Rev. 11-84

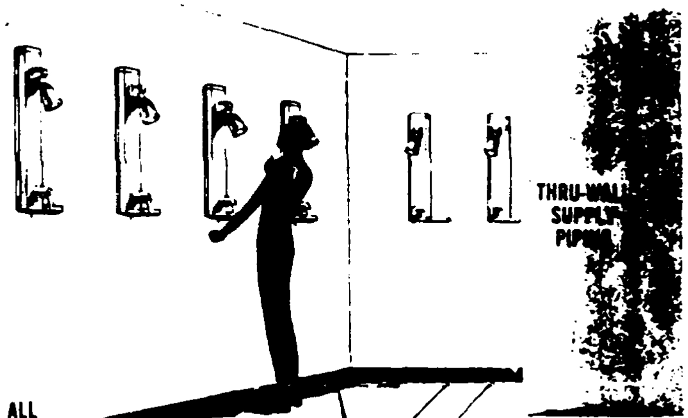
Symmons®

HYDAPIPE® '64'

Modern, Compact, Stainless Steel, Shower Units. The most economical method of designing and installing shower systems

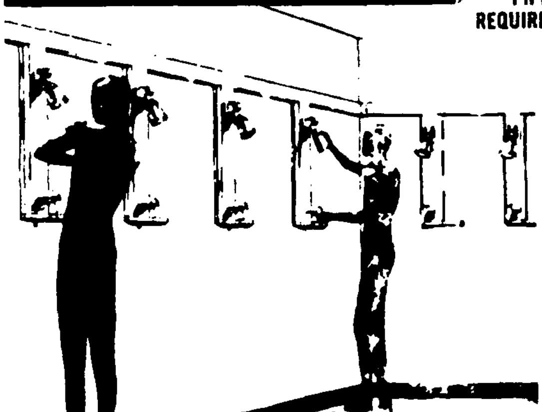


. . . The Original Prefabricated Shower Unit newly designed for wider application. More versatile for the specifier and the installer.
. . . Available in two lengths, standard and short, with vertical or horizontal supply covers.
. . . No pipe chases and narrower walls mean lower construction costs. Neater and far less costly than massive panel showers. Complete unit vandal-proof.
. . . No exposed piping to assemble.
. . . Unit and pipe covering in heavy brush finish, stainless steel with clean, straight line.
. . . All units equipped with famous Symmons Safetymix, the valve without equal.

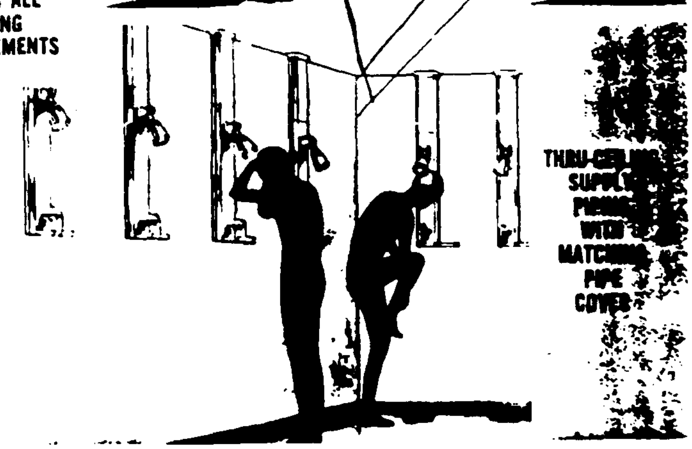


THRU-WALL SUPPLY PIPING

MEETS ALL PIPING REQUIREMENTS



HORIZONTAL SUPPLY PIPING WITH MATCHING PIPE COVERS.

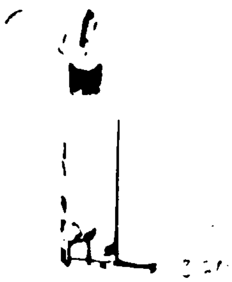


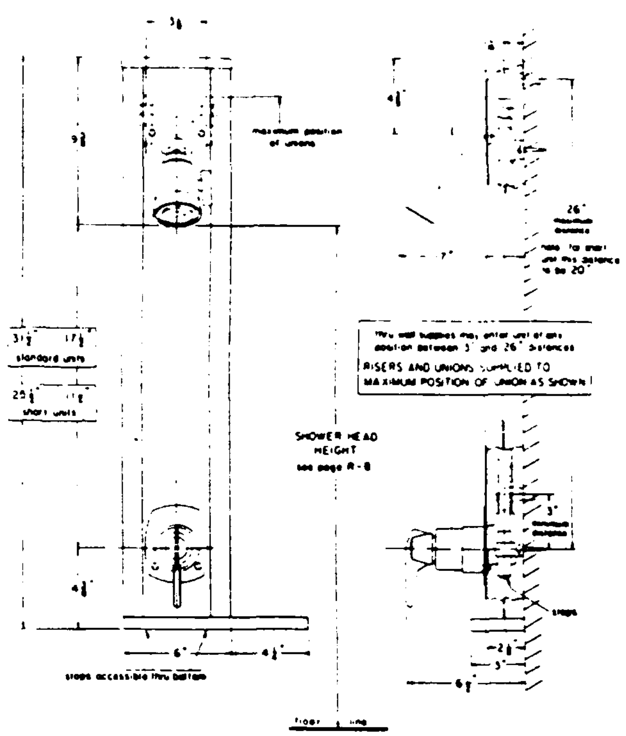
THRU-CEILING SUPPLY PIPING WITH MATCHING PIPE COVERS

SHOWER SAFETY WITH A MODERN LINE

Symmons Industries Inc.,
31 Brooks Drive, Braintree, Mass. 02184

FOR THRU-WALL SUPPLY PIPING





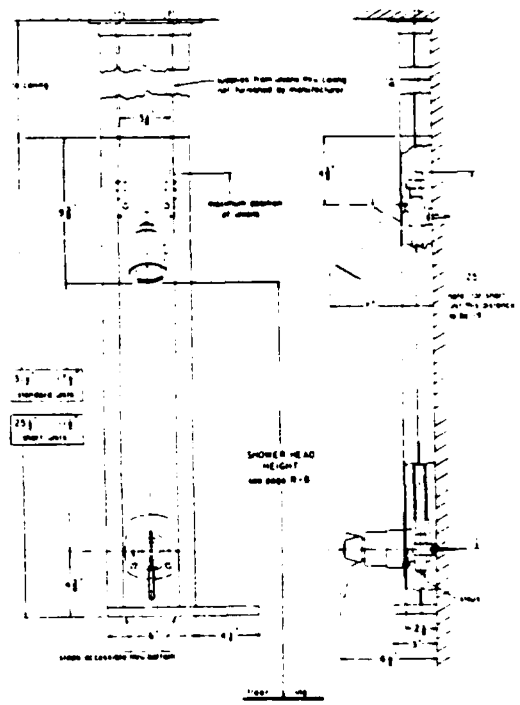
→ **1-801S** Hydapipe '64' Packaged Unit – (STANDARD LENGTH) Safetymix pressure balancing shower valve with integral stops. 'Super' Shower Head on institutional type Head Bracket fitting. Attached soap dish and Top cap. Stainless steel covering to be 18 gauge w/#4 brush finish.
Weight 12¼ lbs.

1-801 Same as above less soap dish.
Weight 11 lbs.

1-802S Hydapipe '64' Packaged Unit – (SHORT LENGTH) Safetymix pressure-balancing shower valve with integral stops. 'Super' Shower Head on institutional type Head Bracket fitting. Attached soap dish and Top cap. Stainless steel covering to be 18 gauge w/#4 brush finish.
Weight 11¼ lbs.

1-802 Same as above less soap dish.
Weight 10 lbs.

FOR THRU-CEILING SUPPLY PIPING WITH MATCHING PIPE COVER



1-803S Hydapipe '64' Packaged Unit – (STANDARD LENGTH) Safetymix pressure-balancing shower valve with integral stops. 'Super' Shower Head on institutional type Head Bracket fitting. Attached soap dish. Matching cover with ceiling flange to conceal supplies to ceiling. Stainless steel covering to be 18 gauge w/#4 brush finish.

1-803 Same as above less soap dish.

1-804S Hydapipe '64' Packaged Unit – (SHORT LENGTH) Safetymix pressure-balancing shower valve with integral stops. 'Super' Shower Head on institutional type Head Bracket fitting. Attached soap dish. Matching cover with ceiling flange to conceal supplies to ceiling. Stainless steel covering to be 18 gauge w/#4 brush finish.

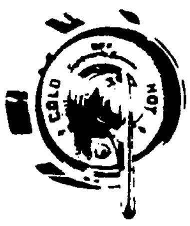
1-804 Same as above less soap dish.

MODIFICATIONS TO ALL HYDAPIPE UNITS
Prefix S Integral Volume Control

SAFETYMIX

CONCEALED PRESSURE BALANCING * VALVE

INSTALLATION INSTRUCTIONS
SERVICE INFORMATION
REPAIR PARTS DATA
* SEE PAGE 4



Manufactured by

SYMMONS INDUSTRIES INC.
31 Brooks Drive, Braintree, Mass. 02184
Tel. (617) 848-2250 Telex 95-1306

All SAFETYMIX* systems are equipped with a 2.75 GPM water and energy saving shower head.

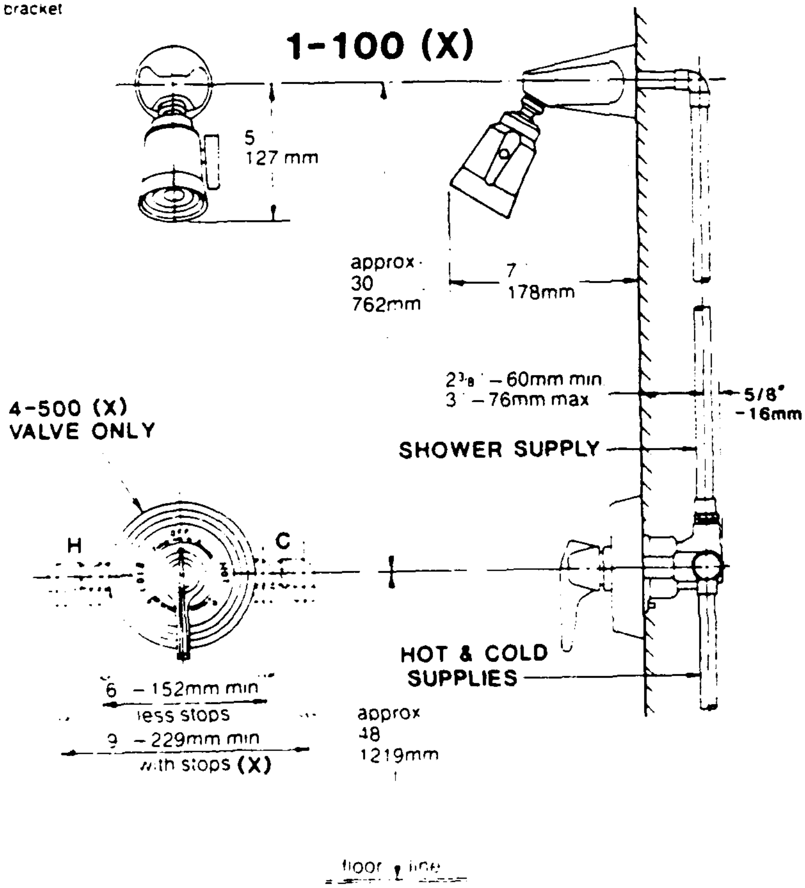
IMPORTANT: After completion of installation step 3, follow these instructions to set the SAFETYMIX Limit Stop Screw. This valve is equipped with a limit stop screw to be used to limit valve handle from being turned to excessively hot water discharge temperatures. To adjust, remove dome cover, open valve to maximum desired temperature and turn in limit stop screw until it seats.
WARNING: Failure to adjust the limit stop screw properly may result in serious scalding.
WARNING: This shower system may not protect the user from scalding when there is a failure of other temperature controlling devices elsewhere in the plumbing system.

This instruction sheet shows the rough-in dimensions for 1-100(X), 1-210(X) or 4-500(X) units. See separate drawings (for other numbered units) for applicable rough-in dimensions.

INSTALLATION OF 1-100

#1-100 SAFETYMIX SHOWER UNIT

Concealed SAFETYMIX pressure balancing valve shower head with NU-ARM head bracket



Valve identification marked on escutcheon
Model O — Valve with temperature control only
Model V — Valve with temperature control and volume control

1. Install rough piping and valve body as shown on installation drawing

IMPORTANT Valve roughing is 2 3/8" min - 3" max from CENTER LINE of SUPPLIES TO FACE of FINISH WALL. Supply connections must be on an accurate horizontal plane

INSTALL HOT ON LEFT AND COLD ON RIGHT ACCORDING TO VALVE BODY MARKINGS

Reverse core valves (i.e. 1-100-REV) designed for piping simplicity on back to back installations are installed with hot on right and cold on left according to valve markings

2. When finishing the tile wall REMOVE ENTIRE PROTECTIVE ROUGH-IN SHIELD and FILL AREA AROUND VALVE BODY WITH GROUT OR PLASTER. DO NOT PLASTER OVER SC-2 CAP OR SERVICE STOPS IF SO EQUIPPED

3. Turn on hot and cold supplies. VALVE WILL NOT OPERATE UNLESS BOTH HOT AND COLD WATER ARE TURNED ON. Allow valve to run in warm position for a few minutes to totally flush system. If system is quite dirty, remove valve spindle or stop spindles (if so equipped) to insure proper flushing

4. Set limit stop screw as directed in bold type above

5. Mount escutcheon onto valve using putty or other sealant around underside of flange. Fasten in place with screw. Install handle with short pointed end at off position. (Put teflon tape or grease on spindle spline) Install NU-ARM head bracket and shower head

6. Do not install positive shut-off devices on the outlet of this valve or devices that do not allow the valve to flow at least 1 GPM @ 50 psi inlet pressure. EXCEPTION: If a self-closing or slow-closing valve is installed on the outlet, the supplies of the valve must be equipped with check stops to eliminate hot to cold by-pass in the event the valves handle is not turned to off after use. Contact your factory representative or Symmons directly for information on available checks

OPERATION

The main handle of the SAFETYMIX valve is for control of temperature only. From the OFF position the handle is turned counter-clockwise through a minimum cold position through a warm and hot position for a maximum turn of approximately one revolution. This allows for infinite temperature adjustments to suit the requirements of any user

IMPORTANT
Read Entire Directions ➧

...these instructions to set the SAFETYMIX Limit Stop Screw. This valve is equipped with a limit stop screw to be used to limit valve handle from being turned to excessively hot water discharge temperatures. To adjust, remove dome cover, open valve to maximum desired temperature and turn in limit stop screw until it seats.
WARNING: Failure to adjust the limit stop screw properly may result in serious scalding.
W ‿ING: This shower system may not protect the user from scalding when there is a failure of other t ‿ature controlling devices elsewhere in the plumbing system.

This instruction sheet shows the rough-in dimensions for 1-100(X), 1-210(X) or 4-500(X) units. See separate drawings (enclosed with other numbered units) for applicable rougn-in dimensions.

INSTALLATION OF 1-210

#1-210 SAFETYMIX TUB AND SHOWER UNIT

Concealed SAFETYMIX pressure balancing valve push button diverter with integral volume control for shower. Shower head with NU-ARM head bracket and tub spout.

Valve identification marked on escutcheon.
Model O — Valve with temperature control only.
Model V — Valve with temperature control and volume control.

1. Install rough piping and valve body as shown on installation drawing.

IMPORTANT Valve roughing is 2⅜" min - 3" max from CENTER LINE of SUPPLIES TO FACE of FINISH WALL. Supply connections must be on an accurate horizontal plane.

INSTALL HOT ON LEFT AND COLD ON RIGHT ACCORDING TO VALVE BODY MARKINGS

Reverse core valves (i.e., 1-210-REV) designed for piping simplicity on back to back installations are installed with hot on right and cold on left according to valve markings.

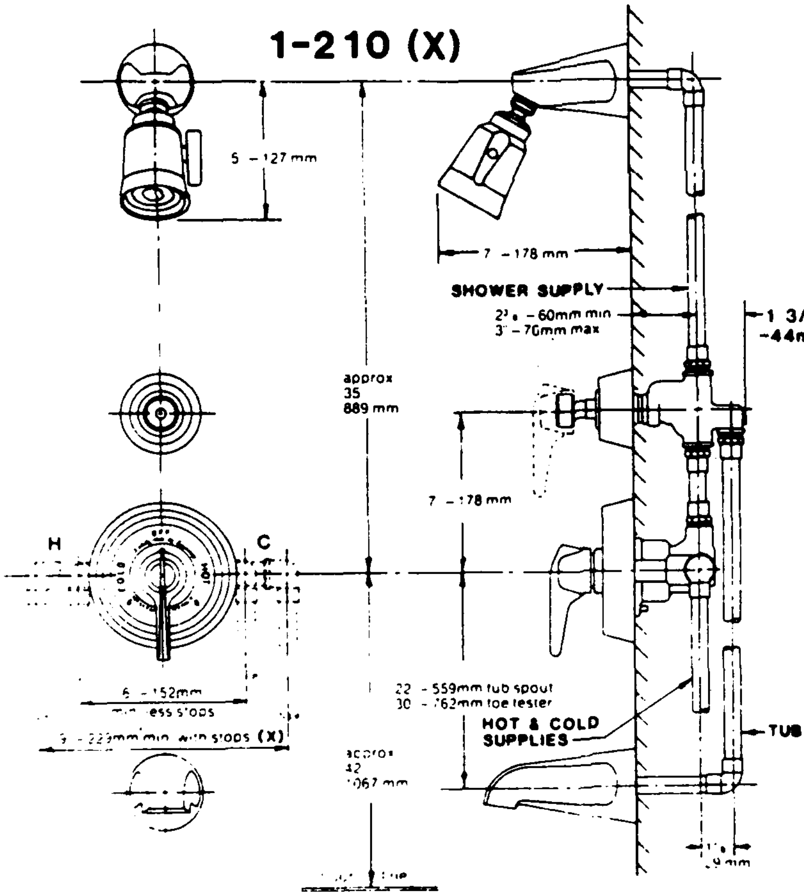
2. When finishing the tile wall REMOVE ENTIRE PROTECTIVE ROUGH-IN SHIELD and FILL AREA AROUND VALVE BODY WITH GROUT OR PLASTER. DO NOT PLASTER OVER SC-2 CAP OR SERVICE STOPS IF SO EQUIPPED.

3. Turn on hot and cold supplies. VALVE WILL NOT OPERATE UNLESS BOTH HOT AND COLD WATER ARE TURNED ON. Allow valve to run in warm position for a few minutes to totally flush system. If system is quite dirty, remove valve spindle or stop spindles (if so equipped) to insure proper flushing.

4. Set limit stop screw as directed in bold type above.

5. Mount escutcheon onto valve, using putty or other sealant around underside of flange. Fasten in place with screw. Install handle with short pointed end at off position. (Put teflon tape or grease on spindle spline). Install NU-ARM head bracket and shower head. Mount escutcheon and knob on diverter.

6. Do not install positive shut-off devices on the outlet of this valve or devices that do not allow the valve to flow at least 1 GPM @ 50 psi inlet pressure. EXCEPTION: If a self-closing or slow-closing valve is installed on the outlet, the supplies of the valve must be equipped with check stops to eliminate hot to cold by-pass in the event the valve's handle is not turned to off after use. Contact your factory representative or Symmons directly for information on available checks.



OPERATION

The main handle of the SAFETYMIX valve is for control of temperature only. From the OFF position, the handle is turned counter-clockwise through a minimum cold position, through a warm and hot position for a maximum turn of approximately one revolution. This allows for infinite temperature adjustments to suit the requirements of any user. Initial flow will come from tub spout. Pressing diverter knob will control volume from shower head.

ALL FLOOR TO CENTER DIMENSIONS OPTIONAL
CONCEALED PIPING NOT FURNISHED BY MANUFACTURER

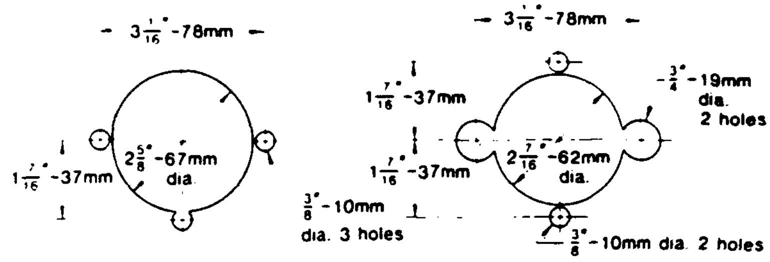
or panel walls and it is desired to sandwich wall between valve body and escutcheon, follow instructions. Note: It is always recommended to secure valve piping to rough construction and not depend on fiberglass wall for valve mounting security.

Order valve with modification "C" for wall [illegible]" - ¾" thick.

Order valve with modification "CM" for wall ⅞" - 1⅛" thick.

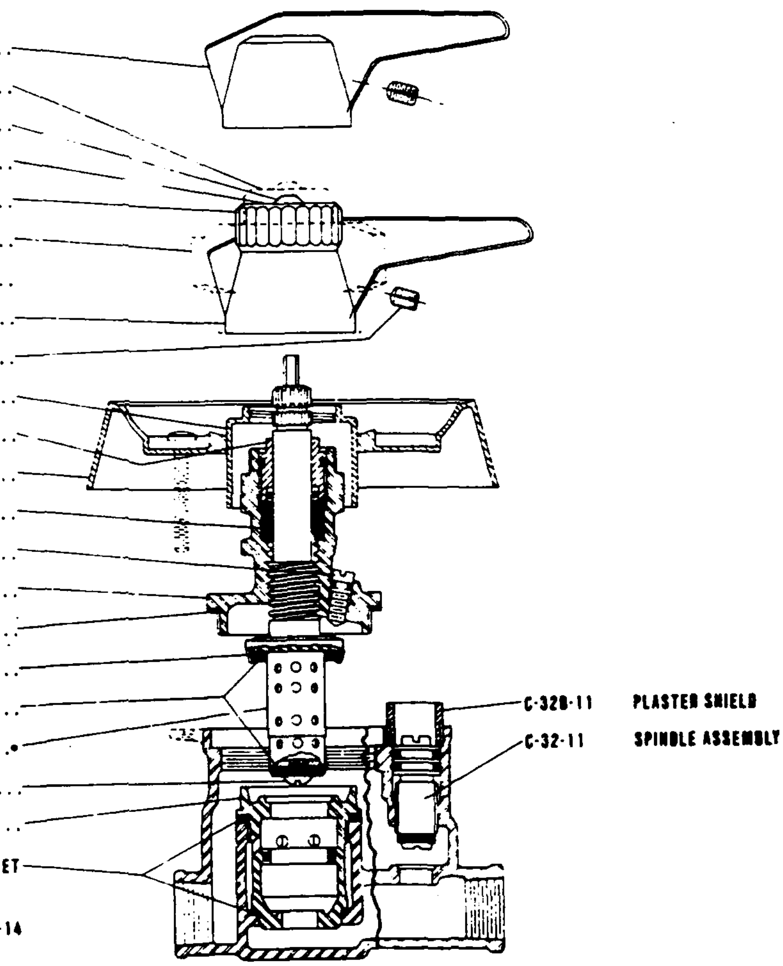
On panel walls over 1⅛" thick, install in conventional manner.

1" 25mm dia hole for NU-ARM head bracket, shower arm, tub spout & toe tester. $1\frac{1}{4}$" -44mm dia for diverter



template for valve less stops — template for valve with stops

RC-14	LEVER HANDLE
DC-14B	VOLUME CONTROL KNOB
SC-14A	LOCKING SCREW W/WASHER
SC-14C	VOLUME DIAL
SC-14B	VOLUME CONTROL KNOB
DC-14	LUCITE HANDLE (VOL. CONTROL)
LC-14	LUCITE HANDLE not shown
SC-14	LEVER HANDLE (VOL. CONTROL)
SC-15	HANDLE SCREW
SC-13 18	DOME COVER & LOCK NUT
SC-7	PACKING NUT
SC-12	ESCUTCHEON & SCREW
SC-17	PACKING
SC-26	LIMIT STOP WITH O-RING
SC-2	CAP
SC-19	CAP GASKET
SC-9	COLD WASHER RETAINER
SC-10 11	HOT & COLD WASHERS
•	FLOW CONTROL SPINDLE
SC-10A	HOT WASHER SCREW
SC-3	RENEWABLE SEAT
SC-20A 21	TOP SEAT O-RING & BOTTOM SEAT GASKET



Note: For valve less volume control, use RC-14 or LC-14 handle & C-5 flow control spindle assembly.

SAFETYMIX WASHER & GASKET KIT-B

SC-9	COLD WASHER RETAINER
SC-10/11	HOT & COLD WASHERS
SC-17	SPINDLE PACKING
SC-19	CAP GASKET
SC-10A	HOT WASHER SCREW
SC-15	HANDLE SCREW

REPAIR UNITS (Complete with Washers)

SC 3	RENEWABLE SEAT UNIT Complete
•C-5	SPINDLE ASSEMBLY MODEL B (Less Volume Control)
•SC-5	SPINDLE ASSEMBLY MODEL V (Volume Control)

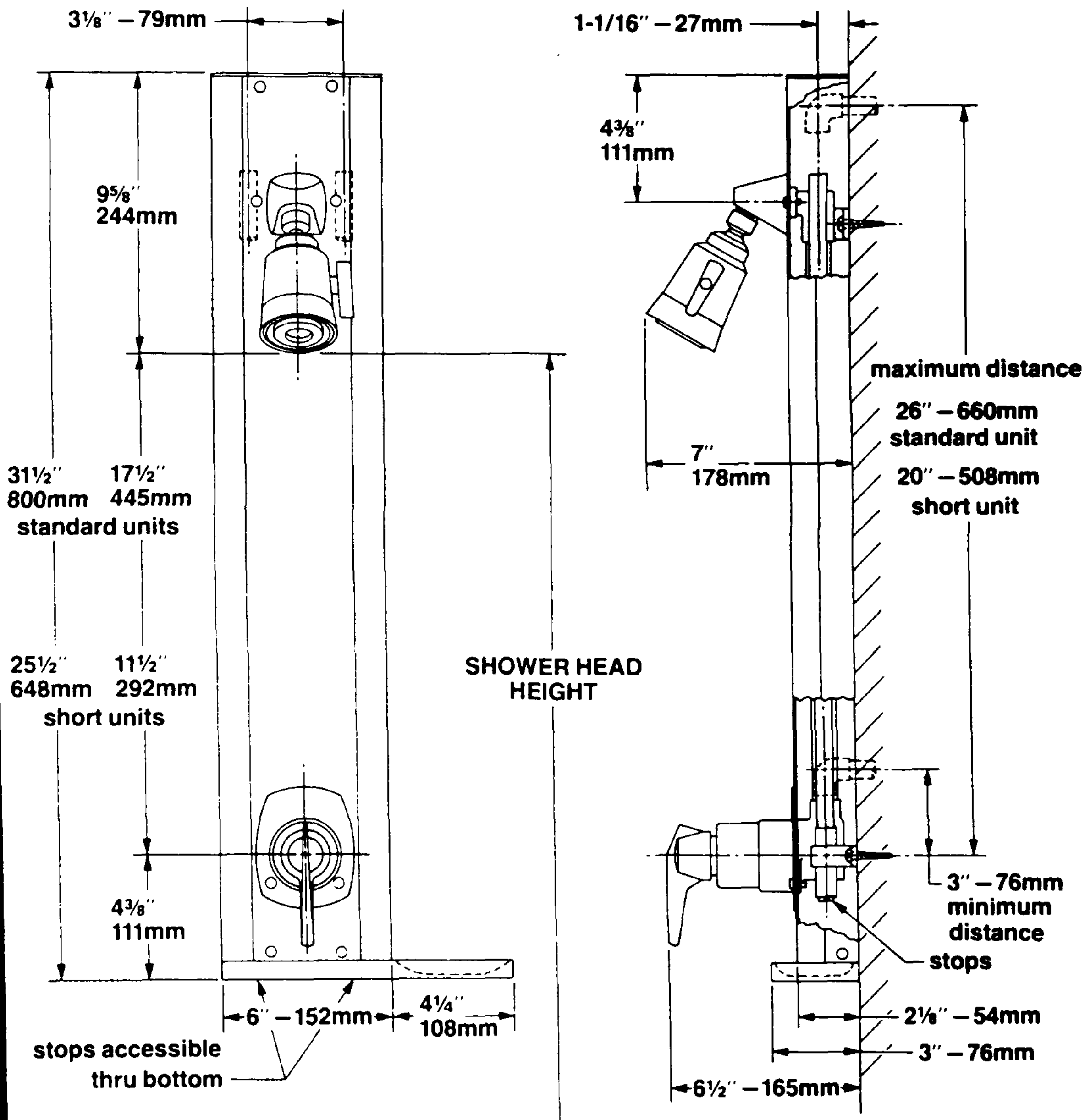
Note: When valve has a high frequency of use and requires repair, replace Renewable Seat and Spindle Assembly simultaneously.

C-58 RENEWABLE SEAT SOCKET WRENCH

THIS
PAGE
IS
MISSING
IN
ORIGINAL
DOCUMENT

56 - 57

I-801S	HYDAPIPE packaged unit (STANDARD UNIT) complete with SAFETYMIX with integral stops, SUPER shower head & attached soap dish.
I-801	Same as above less soap dish.
I-802S	(SHORT UNIT)
I-802	(SHORT UNIT) Less Soap Dish



This drawing to be used for rough-in installation only. For complete installation, adjustment and service information, see Safetymix Form #S-3.

floor line

thru wall supplies may enter at any position between minimum and maximum distances shown

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