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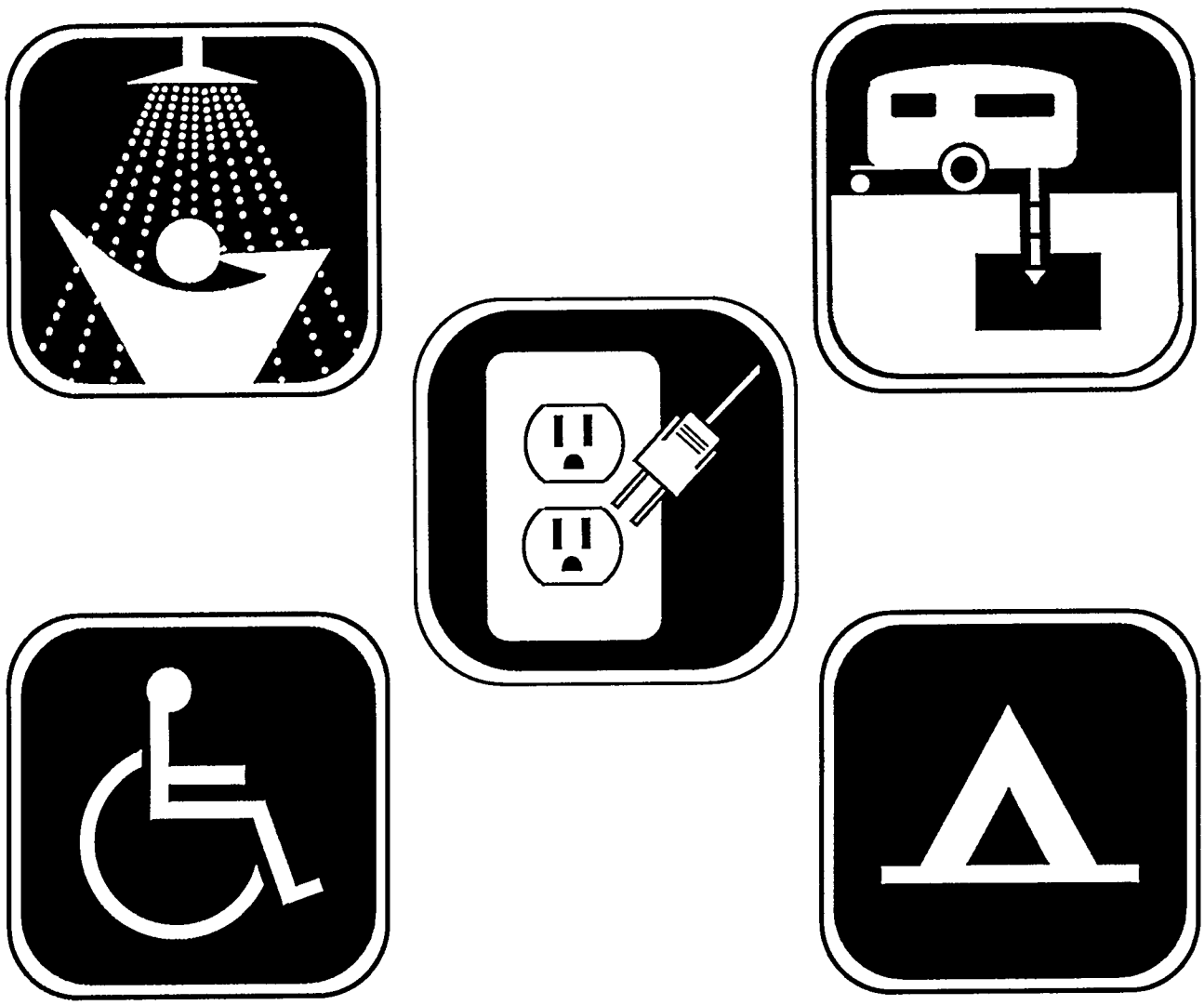
UTILITY HOOKUPS FOR CAMPGROUNDS

A General Guide for Designing and Maintaining Shower, RV Sanitary Dump Stations, and RV Electrical Service Equipment



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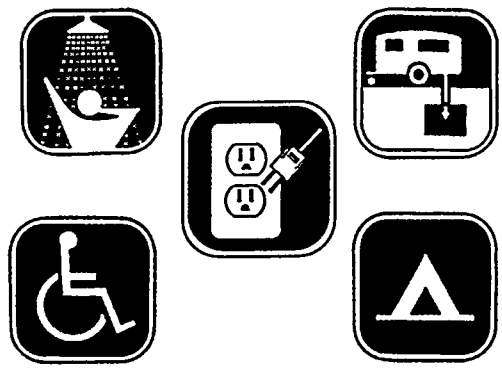

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The objective of this publication is to serve as an information guide for recreation facility planners, designers, unit managers, and maintenance personnel in selecting the hardware that will minimize future maintenance costs while satisfying the needs of the customer.

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FOREWORD

The President's Commission on Outdoor Recreation identified the need to provide recreation opportunities for a diversity of users. The nation's urban centers have created environments filled with common services often viewed by rural communities as luxuries.

The population of senior citizens from urban centers will continue to grow, and the increased leisure time will allow frequent visits to places such as public recreation areas. This segment of the population bring with them a different set of values—expecting and demanding better services and quality facilities from their public lands.

This publication will help to assist managers of the national forest in making rational decisions in providing low-maintenance, high-quality public facilities.

The regulations regarding treatment of waste generated from showers and recreational vehicle dump stations vary from one State to another. There are several reports already published by independent and State environmental departments; therefore, this report will not address the subject of waste treatment. It is suggested that you contact your local sanitary engineer for methods approved in your location.

INTRODUCTION

Public showers, recreational vehicles (RV) sanitary dump stations, and utility (electrical) service hookups have not been the traditional service amenities provided in national forest campgrounds.

Showers and electrical hookups are provided primarily for user comfort. These on-site developments are compatible with the prescription for "**Rural**" and "**Urban**" Recreation Opportunity Classes within the Recreation Opportunity Spectrum (ROS) framework. It is important to note that the size and degree of complexity of the on-site development is a measurement of the facility's compatibility with the site's designated ROS class. It may be possible to have shower facilities within a "roaded natural" class as long as the facility design is in harmony with the site's other ROS setting indicators, i.e., access, remoteness, naturalness, social encounters, visitor impact, and visitor management.

This report provides information on design and maintenance considerations needed to construct a functional and accessible facility. It is intended to serve as a summarized equipment catalog, describing commercially available fixtures and selected hardware—many of which are presently used in public facilities.

SHOWERS

Customer Needs

The users of shower facilities appreciate a well-maintained facility. Secure and sanitary appearance is high on their list of priorities and contributes to a satisfactory experience.

Customer satisfaction is usually measured against experiences the user is accustomed to in his/her own home environment. To obtain the greatest customer satisfaction the facility manager must closely meet the user's expectation and need for safety, security, sanitation, and cleanliness.

Items such as sufficient warm/hot water; odor-free private shower stalls and dressing areas, with adequate sloping floors to prevent ***any*** water collection and places to hang clothing; adequate lighting; and clean non-slip floors are important components comprising a quality facility.

The bather will spend an average of 5 to 10 minutes to complete a shower, utilizing about 20 to 40 gallons of water. The typical bather takes his/her shower in the morning—between the hours of 6 am and 10 am, or in the evening—between 6 pm and 10 pm. At ambient air temperatures of 75 to 80 degrees F, comfortable water temperatures will range from about 90 to 95 degrees F. However, this may vary between individuals as relative humidity affects the body's response to temperature changes. Scalding conditions are detected by the body when water temperatures are above 105 degrees F, for most people. Damage to skin occurs at 110 to 115 degrees F.

Design and Maintenance Consideration

Selecting the appropriate building design can assist the manager in meeting the needs, or capacity, of the site. The proper design also allows the most efficient use of the maintenance person's time by assisting him/her in regularly scheduled cleaning.

It is difficult to project the impacts showers will have on actual use of a recreation area. Over-estimating the projected use capacity can be costly; however, it assures the facility will meet the public's needs during peak use, primarily weekends and holidays.

As a general rule—shower facilities can be designed to meet moderate use capacity by providing one shower for every 40-50 persons. Some planners have applied a standard design ratio of 8 shower stalls per 60 camp units, for moderate to heavy use. Based on 5 people at one time (PAOT) per campsite, this ratio equates to about one shower stall per 38 people. In most instances, the facility should provide no less than two showers for men and no less than two showers for women. Note, this estimation may vary and, to some extent, is dependent on the type of recreation activity and climate.

This rule complements current Forest Service guideline of providing one toilet seat for every 35 persons (FSM 2333.51).

Building Design

There are two shower building designs in use: The traditional design which clearly allocates separate mens and womens shower compartments; and the unisex design which is a more liberal design allowing private use by either gender.

The **"traditional"** design for public showers designate separate showers for male and female bathers. This has been the standard arrangement for comfort stations and bathing facilities (fig. 1). In bathhouses, this arrangement facilitates the use of central or communal dressing areas and contributes to reducing the size of the facility. This design also allows, though not well accepted by some adult bathers, the use of less private column-type showers like those found in athletic facilities and penal institutions. (See Shower Plumbing Systems section.)

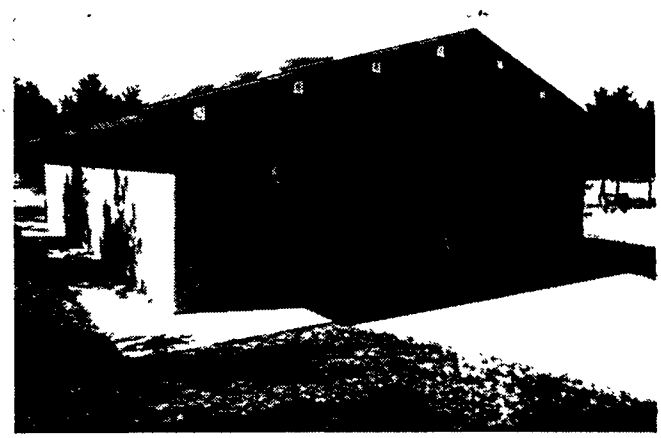


Figure 1. "Traditional" shower building design, Oregon Dunes National Recreation Area.

Unisex showers have become an accepted design (fig. 2) in recent years. This design provides versatility for the user by allowing, especially for people with disabilities or small children, privacy, security, and assistance by a spouse or companion of the opposite sex.

Other attributes of this design include the following:

- Provides a constant supply of showers for the public. (Traditional showers, on the

other hand, allow showers to be left idle if the campground happens to have more male bathers than females, or vice versa.)

• Provides for a more efficient maintenance program. (Unlike traditional showers, the entire comfort station does not require closure to accommodate cleaning and maintenance.)

• Improves administrative controls by allowing closure of individual shower compartments during reduced demand or emergency repairs.

Figure 2. "Unisex" shower building design, Oregon State Parks.

Maintenance

Maintenance of shower facilities normally consists of cleaning the wall/floor surfaces and repairing or replacing worn fixtures and other hardware. In cooler climates, the plumbing system must be winterized—a complicated task in older shower buildings.

Controlling surface mold and mildew is a prevalent problem in shower buildings. Mold and mildew frequently form on warm, damp surfaces in environments having little or no air circulation (Fig. 3a). Mildew-resistant paints help control, but do not solve the problem. Mechanical ventilators or fans appear to be the most effective method of circulating air. However, passive methods have been used with some success. In passive venting, the building is constructed with vaulted ceilings; screened windows or vents are installed near the ceiling. This combination results in convective air movement. Note: To take advantage of prevailing winds, the upper building vents should be facing the lee side of the prevailing winds and the floor vents should be installed on the windward side. The result is a constant movement of air, a "push-pull" effect. The prevailing winds will push air into the building through the windward facing floor vents and pull moist air out the leeward facing ceiling vents.

Floor corners are difficult to clean, and removal of mold and dirt is often avoided by the cleaning staff. Coving or curving these corners will assist maintenance personnel in the cleaning of these areas. Weekly scrubbing with a solution of chlorine bleach and water also helps control mold and mildew.

*(**CAUTION:** Do not mix chlorine bleach with ammonia cleaners or other chemicals, as they react releasing toxic fumes.)*

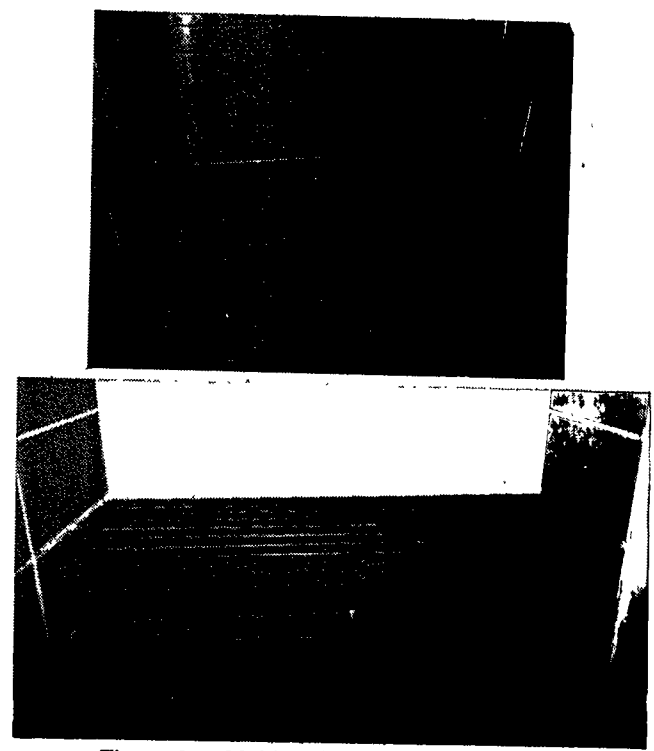


Figure 3a. Mold and mildew forming under dressing area bench and shower stalls.

The accumulation of soap residue (fig. 3b) is another common problem in shower facilities. This residue is the result of soap additives combining with body oils. If left to accumulate, the removal is difficult. Commercially available foam cleaners can assist in loosening the residue. However, experience has shown that daily to weekly scrubbing avoids the more difficult task of removing surface cured residue. The accumulation of residue can be controlled with the proper type and good placement of wall-mounted soap trays or dishes. Recessed, wall-mounted soap dishes, typical of those found in the home, can be difficult to clean. However, they are more vandal-resistant than those that extend away from the wall. Some soap dishes are designed with a small towel bar. This type

of design should be avoided, as it makes cleaning difficult.

The soap dish should be installed against a smooth vertical surface, free of tile seams or crevices where dissolved soap residue draining from the dish can accumulate. Another consideration is to mount the dish lower to the floor and away from direct spray of the shower; i.e., no higher than 40-in above the floor and on the same wall as the shower head. (Note: This is an adopted specification standard for the State of California, to accommodate people with disabilities.) The lower height will reduce the travel distance of soapy residue along the wall, thereby reducing the surface area needing to be cleaned. Some manufacturers of plumbing fixtures provide optional built-in soap dishes with their control fixture panels. In no case should the soap dish be installed directly above the control valve because of the difficulty of cleaning the control valve finish after the soap residue drips down over it.

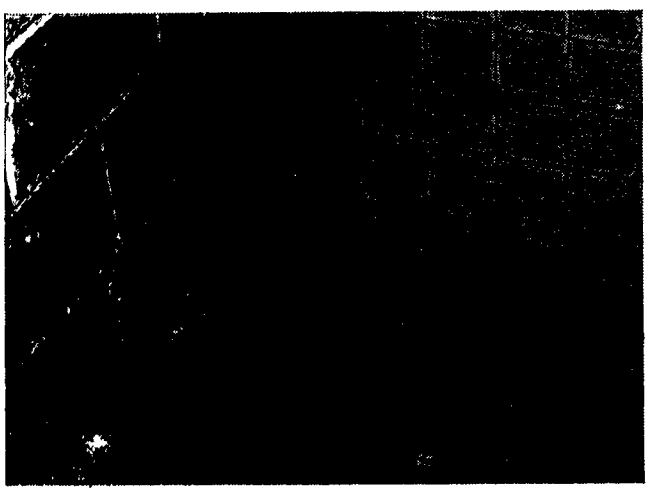


Figure 3b. Soap residue collecting in tile grout.

Plumbing Chase/Storage Area

In cool climates, the plumbing system must be winterized. Depending on location, winterization can consist of heating the plumbing or completely draining the system. The latter method is most common but requires a central fall point for draining the water out of fixtures, water heaters, and service lines. The fall point, or low spot in the plumbing, should be well below the frost line and accessible by maintenance personnel. In existing plumbing systems where fall points are incorrectly located or not provided, the service lines can be cleared with the use of compressed air.

The plumbing chase or "pipe chase" of many existing buildings is confining, usually less than 4-ft wide. These compartments often double as storage areas, leaving little room to perform preventative maintenance inspections and repairs (fig. 4). Building designs should provide sufficient storage space for cleaning supplies and equipment—in addition to accommodating several water heaters.

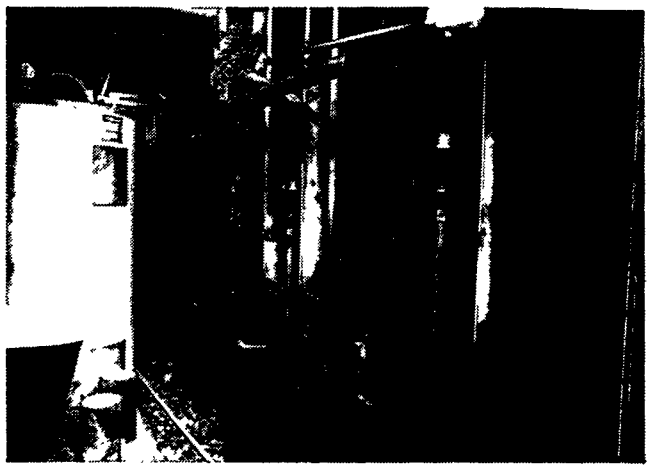


Figure 4. Typical plumbing pipe chase used for storage—space is limited for conducting maintenance, repairs. Wet mops hung from pipes puts a strain on pipe connections.

NOTE: The flush-valve fixtures are installed high above water source, allowing easy draining for winter.(Top)

Wall Surface Materials

Durability (or vandal-resistance) and ease of cleaning

are two major considerations in the type of materials selected for shower walls and dressing area partitions. Table 1 provides a summary of wall surface materials used for shower facilities.

Table 1. Comparison table of selected wall surface materials for public and institutional shower facilities

Type	Durability	Cleaning	Other Comments
Porcelain enamel on steel	Good	Easy	Available in sheets reducing seams. Can be chipped.
Reinforced fiberglass	Good	Easy	Can be burned but inexpensive to replace.
Glazed masonry block	Good	Fair	Grout seams must be sealed.
Tile, ceramic	Good	Fair	Grout seams must be sealed. Frost-heave damage is experienced in some applications.
Plastic tile topping	Fair	Fair	Can be used to coat old surfaces. Can be scratched.
Epoxy coating on masonry	Poor	Difficult	Must be recoated frequently to prevent flaking.
Epoxy topping	Good	Fair	Applicator must be highly skilled.

*(**Note:** Suppliers for the above wall surfacing materials are listed in Appendix I.)*

Floor Surface Materials

Selecting a durable floor surface material is one of the most important decisions in designing a shower building. It is the first and last item observed and remembered by the user. Maintenance personnel usually regard the best floor surface as one that has a long "half-life" (durability) and presents the least cleaning difficulty. The slope in the floor and number of drains can assist the maintenance person in keeping the floors sanitary and dry. Often, there are not enough floor drains nor are the floor slopes great enough to reduce puddling. The slope must be greater than 1/4-in per foot. Characteristics such as aesthetics (color), durability, abrasiveness and cost usually determine the type of flooring material selected. Table 2 provides a summary of floor surface materials used for shower facilities.

Table 2. Comparison table of selected floor surface materials for public and institutional shower facilities

Type	Durability	Ease of Cleaning	Slip-resistance	Comments
Concrete epoxy coatings	Fair	Fair	Low	Requires thick coat. Floor preparation is critical.
Concrete seal and coatings	Fair	Fair	Medium	Difficult to keep sealed.
Quartz broadcast epoxy-resin topping	Good	Fair	High	Can be molded to form corner coves. Requires skill to apply.
Quarry tile, unglazed	Excellant	Good	Medium	Grout seams must be cleaned and sealed.
Plastic interlocking tiles	Good	Difficult	High	Must be disassembled for cleaning.

*(**Note:** Suppliers for the above floor surfacing materials are listed in Appendix I.)*

The condition of the existing concrete floor surfce or substrate will determine what surface coverings (i.e., tiles, resin coatings, or toppings) are feasible. Irregularity in the substrate is difficult to correct with tile flooring or resin coatings. The difference between a topping and a coating is their applied thickness. Coatings are thinly layered products, such as paints or liquid sealants. Toppings are thicker, often applied with a trowel.

If ceramic tile flooring is preferred, the practice of using small 1-in square tiles (fig. 5) provides a better slip-resistant surface than if standard 4- to 6-in square tiles were used. However, as observed in several installations, the smaller tiles often require more scrubbing to remove the dirt and soap which accumulates in the grout seams. A surface sealant used with a dark pigmented grout helps to reduce trapping dirt and soap film and overcomes the unsightly appearance of mold stains absorbed in the grout.

Figure 5. Ceramic tile flooring.

Dressing Area

The dressing area is often overlooked as an important component of the shower facility. To the user, the presence of a clean, dry floor surface is of major importance. The accumulation of water caused by an incorrectly placed shower head (fig. 7) and/or people tracking water from the shower makes it difficult to keep the dressing area floor dry. The dressing area floor should be sloped 1/2-in per foot. Plastic, perforated interlocking tiles that serve as platforms off the shower floor helps to reduce tracking water into the dressing area. However, they must be cleaned frequently, adding to the maintenance costs.

Communal or group-type showers and dressing areas are commonly used in institutions and beach areas. However, today's modest public prefer private dressing areas where personal belongings such as a wallet, articles of clothing, and toiletry are within view.

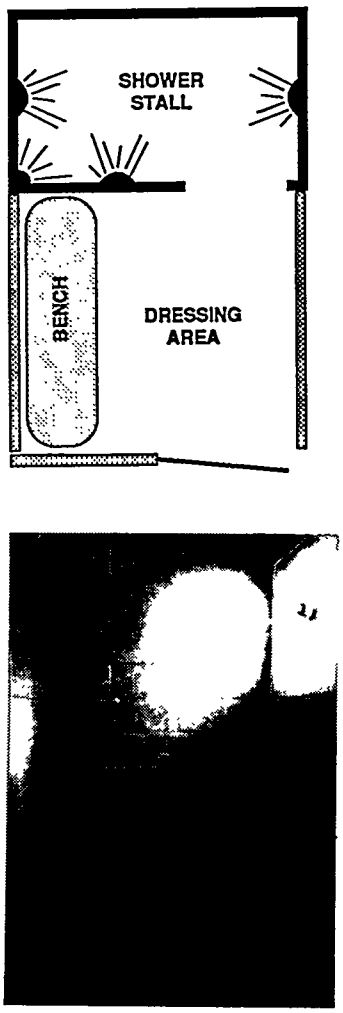


Figure 6. Good placement of the shower head. Spray is directed away from dressing area.

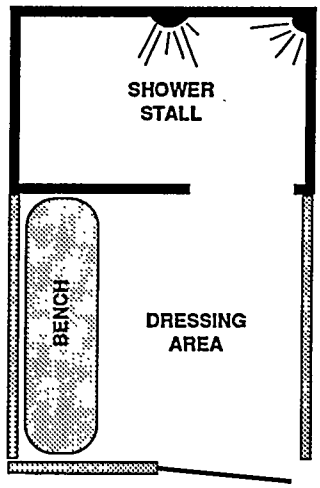


Figure 7. Poor placement of the shower head. Spray is directed at the dressing area .

A sturdy shelf (fig. 8), waste receptacle (fig. 9) and clothes hook (fig. 10) will enhance customer satisfaction. However, providing such amenities requires additional maintenance (i.e., cleaning, replacement, etc.) and should be considered in the overall cost of maintenance. All shelves, waste receptacles and other protruding fixtures should be made of noncorrosive material and have rounded corners/edges to reduce the risk of serious injuries during an accidental slip or fall.

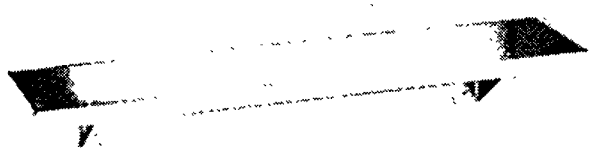


Figure 8. Stainless steel shelf. Courtesy of Bobrick Washroom Equip.

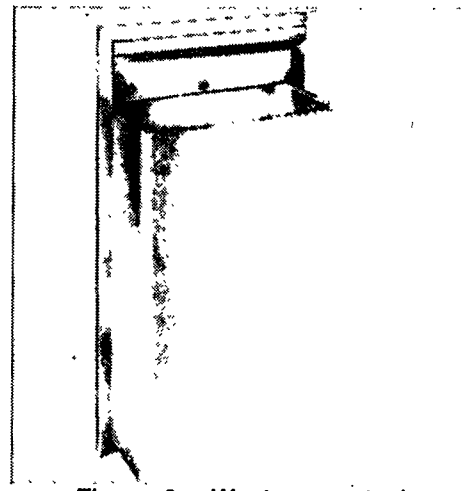


Figure 9. Waste receptacle. Courtesy of McKinney Washroom Accessories.

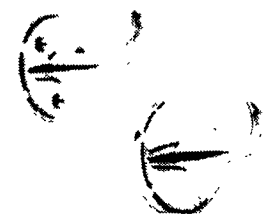


Figure 10. Clothes hooks. Courtesy of McKinney Washroom Accessories.

Benches (fig. 11) are a necessary item in dressing areas. However, they are often used to stand on, rather than sit on for the purpose of dressing or undressing. This is because benches often provide the only clean, dry platform off the wet unsanitary floor. Wooden benches are difficult to maintain in moist environments. Benches with solid plastic tops or permanently built-in (fig. 12) are very durable. Longer benches should be considered in lieu of providing a separate bench and shelf, if space is available. Support brackets for benches must be sturdy enough to support the weight of a person and be resistant to corrosion. Stainless steel hardware is available through most distributors of marine boating supplies.

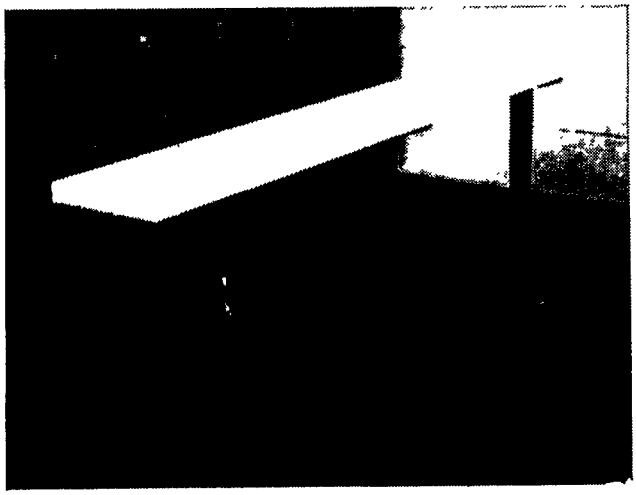


Figure 11. Plastic top bench. Courtesy of Santana Products, Inc.

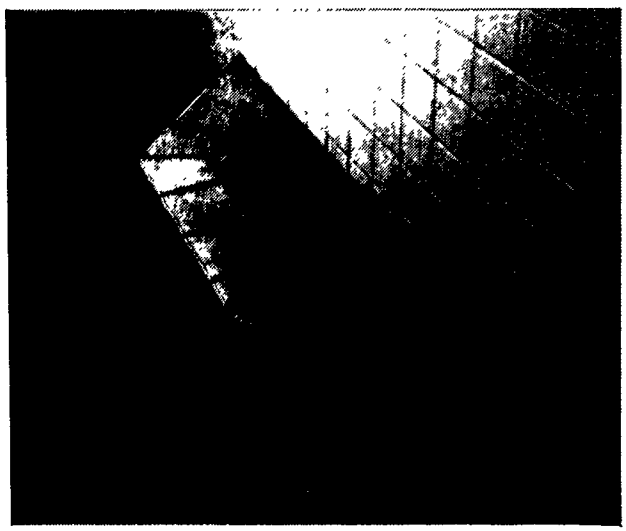


Figure 12. Built-in bench, Oregon Dunes NRA.

Service faucets should be provided to assist maintenance personnel in cleaning each shower compartment. This faucet should be concealed inside a recessed (fig. 13) wall enclosure to reduce vandalism and accidental injuries to the bather.

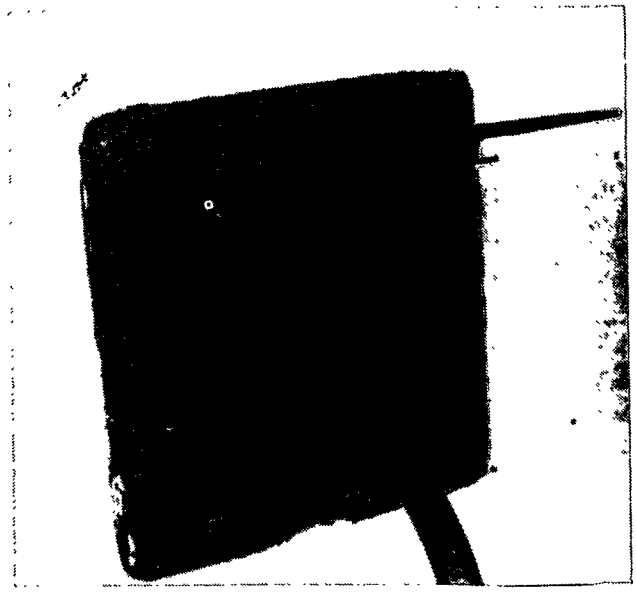


Figure 13. Service faucet mounted inside a recessed faucet box.

Waiting benches are furnishings that should be provided at all shower facilities. The benches provide the awaiting bather with basic sitting accommodations and assists in establishing a system of self-regulating use at the facility. The benches should be sheltered from the rain or sun and placed preferably outside the building. Placing them outside the building allows campers within the surrounding area to see in advance how crowded the facility is.

Access for People with Disabilities

All newly constructed and reconstructed shower facilities must be made **accessible** to people with disabilities. Standard dimensions (fig. 14) for shower compartments are prescribed in the Uniform Federal Accessibility Standards (UFAS), published by the Architectural and Transportation Barriers Compliance Board (ATBCB).

The design must include the following hardware: Waterproof shower seat; grab bars; and a lever or push-button type control fixture (fig. 15). The shower head should be hand held, to allow coverage over the entire body. While hand showers provide the greatest user application, they include a detachable hand-held sprayer (fig. 16a) on a flexible hose—a fixture easily vandalized. The alternative to a hand-held shower is a dual, fixed-mounted, shower head (fig. 16b). In this design, a directional control valve can be adjusted to divert water to an upper or lower shower head, thereby accommodating people with various types of disabilities. This design is not as accommo-

dating for some disabled users, but it is still an acceptable design that allows the shower spray to be directed closer to the immobile bather.

NOTE: Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls shall be no greater than 5-lb force.

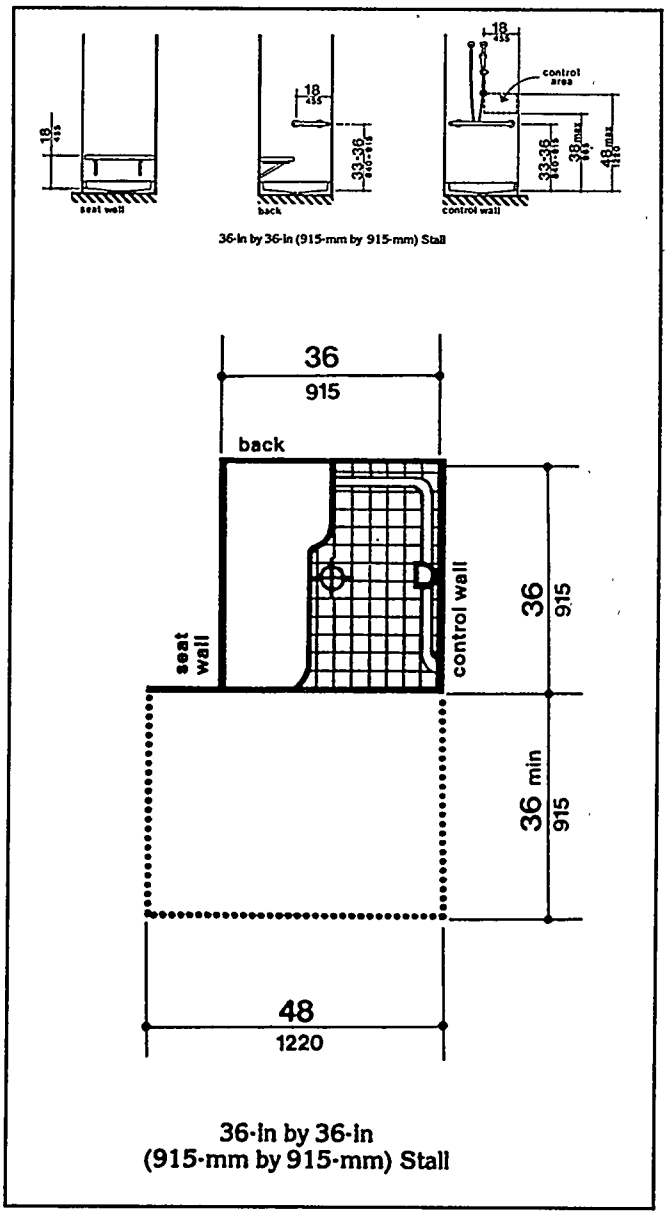


Figure 14. Standard shower dimensions for accessible showers, as prescribed in UFAS.
[Reprint from Uniform Federal Accessibility Standards.]

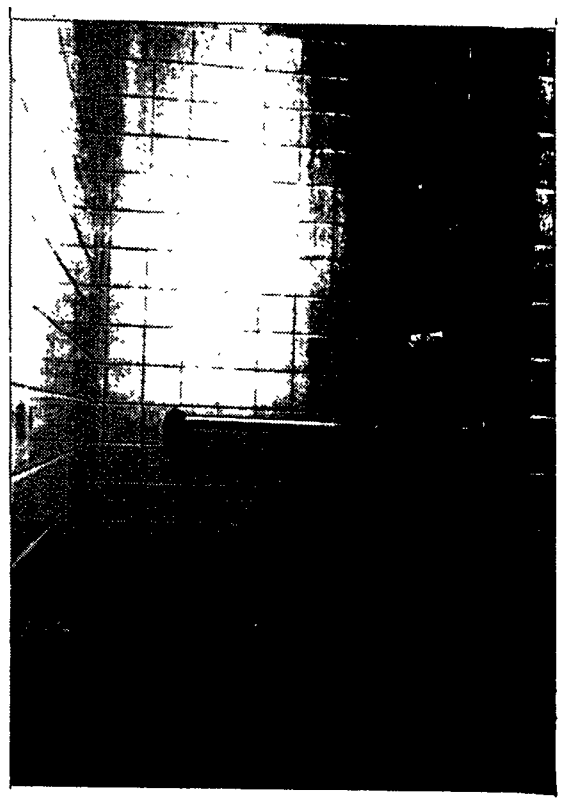


Figure 15. Accessible shower design.

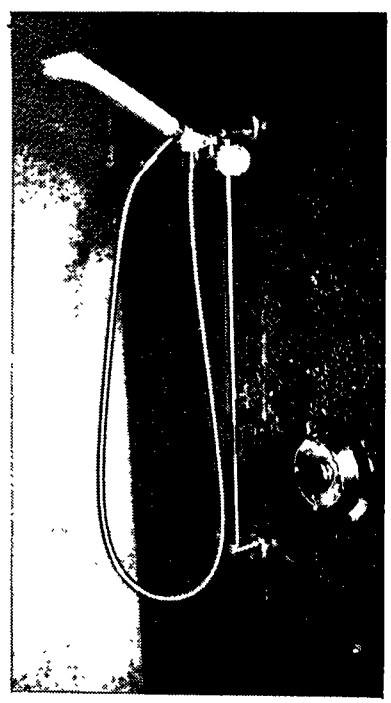


Figure 16a. Hand-held shower head.

Figure 16b. Dual shower heads, Oregon State Parks.

Shower Plumbing Systems

The three principal components common to all shower plumbing systems include: Shower control valve; shower head; and water heater. Waste treatment is an external component and equally important. However, to stay within the scope of this publication, waste treatment methods and waste design considerations will not be discussed. (There are numerous publications available on this topic.)

From a managerial perspective, "vandal-resistant" and "maintenance-free" characteristics top the list of importance in selecting shower components. While from the user's perspective, "simplicity" and "adequate supply of hot water" usually ranks the highest on the list of importance.

Shower controls can either be mounted to the wall or used with column units.

Column type shower units (fig. 17) have best application in situations where the objective of providing showers is to move bathers through the facility as quickly as possible to accommodate many users during peak use (i.e., typically used in schools and penal institutions). They are less private and sometimes regarded as unacceptable in campground application. However, designs are available that divide the unit into sections through the use of partitions or curtains. (Manufacturers of column units include Acorn Engineering and Bradley Corporation.)

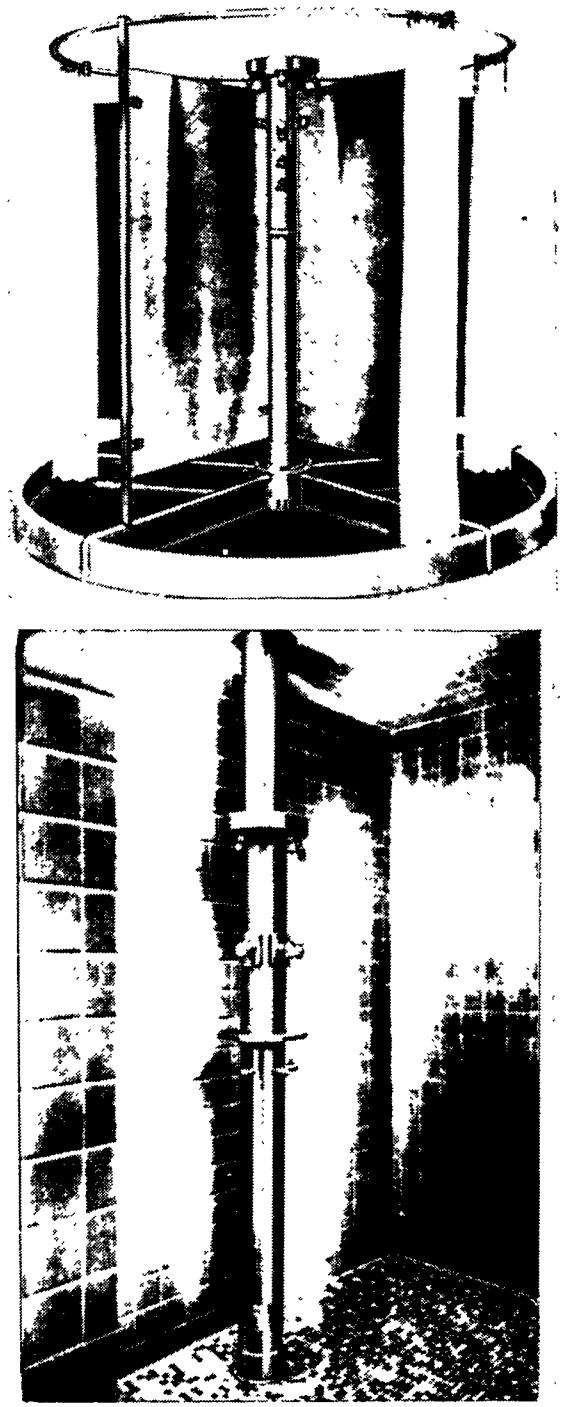


Figure 17. Multi-person, column-type shower unit. Courtesy of Bradley Corp.

In wall-mounted installations, the shower controls and plumbing pipes are typically recessed in the wall, openly exposed, or concealed behind an enclosure or panel. Recessed plumbing fixtures are the most vandal-resistant, but must be recessed in walls adjoining the plumbing chases. This type of installation usually requires larger plumbing chases for accessing the control valves. Exposed plumbing should be avoided, as it can present

a safety hazard, it is the least vandal-resistant and often aesthetically displeasing. When space prevents concealment, exposed plumbing is sometimes the only option available for renovated shower buildings; however, exposed hot water pipes present a hazard to users. To improve appearance and reduce the hazard of exposed pipes, wall-mounted stainless steel enclosures are commonly used, allowing placement of the controls and shower head on any wall. Table 3 provides a summary of selected wall-mounted control units for shower facilities.

Table 3. Comparison table of selected wall-mounted control panel units for public and institutional shower facilities

Mfg.	Model	Mounting feature
Acorn	1061	wall
Bradley	Bradsole 1K	corner
Bradley	Bradsole 1W	wall
Leonard	Surfashower	wall
Powers	Hydropanel	wall
Symmons	Hydapipe 64	corner
Symmons	Hydapipe 64	wall
Willoughby	Built-in Panel	recessed

Notes: *Costs are not provided in this table due to the variation in available options (valves, shower head, soap dish, etc.) that affect total cost of the panel unit.*

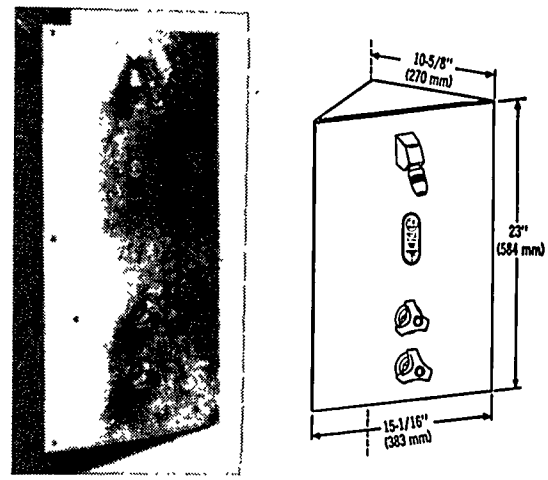


Figure 19. Bradley, "Bradsole 1K" (corner mount). Courtesy of Bradley Corp.

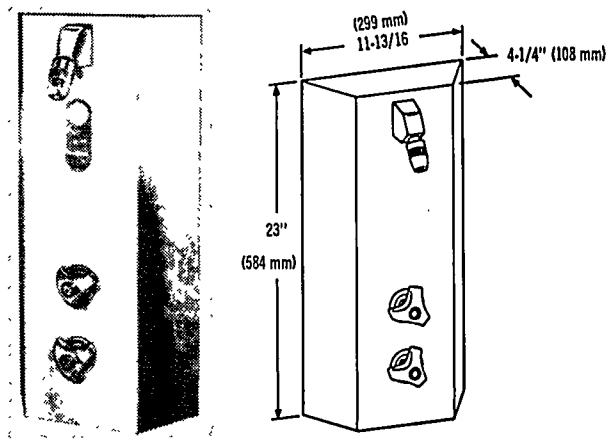


Figure 20. Bradley, "Bradsole 1W." Courtesy of Bradley Corp

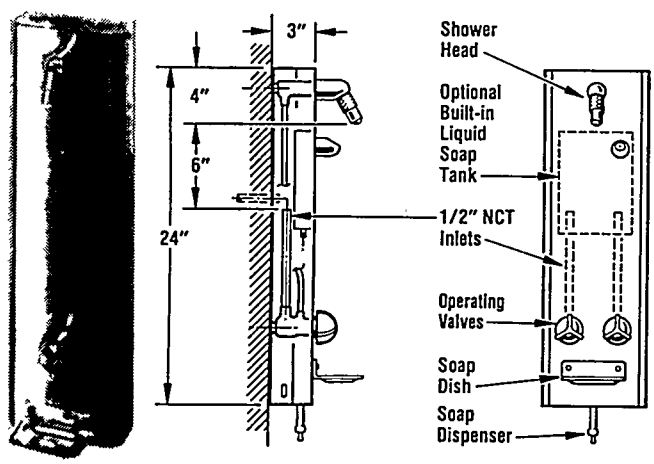


Figure 18. Acorn, Model 1061. Courtesy of Acorn Engineering, Inc.

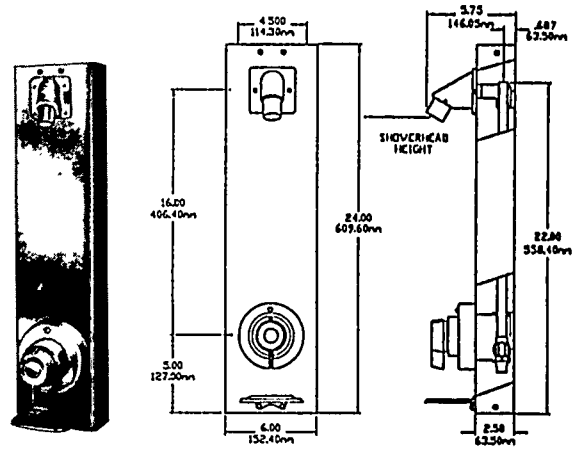


Figure 21. Leonard, "Surfashower". Courtesy of Leonard Valve Co.

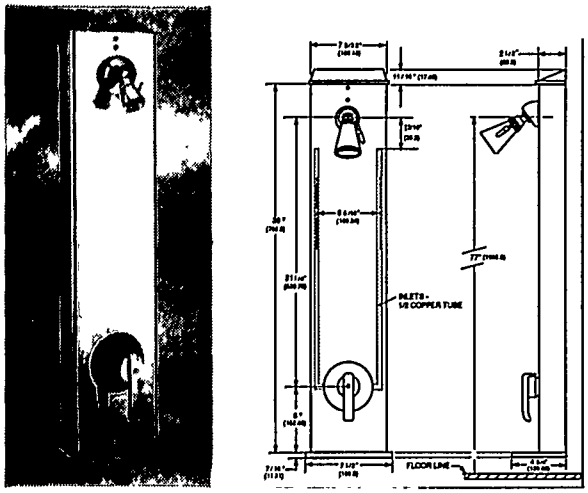


Figure 22. Powers, "Hydropanel." Courtesy of Powers Process Controls.

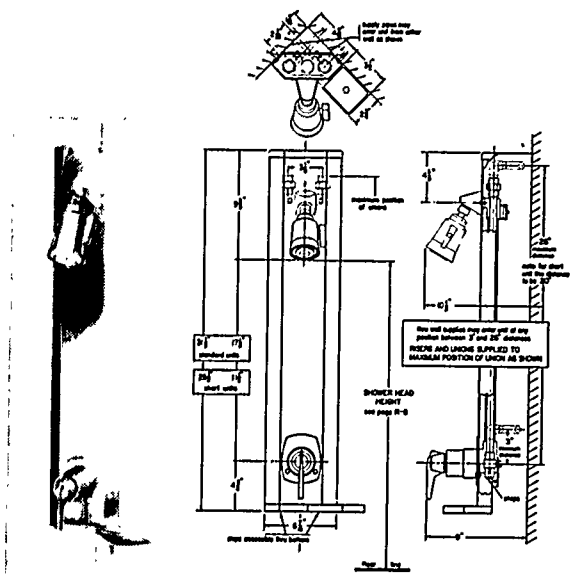


Figure 23. Symmons, "Hydapipe 64" (corner mount). Courtesy of Symmons Indust., Inc.

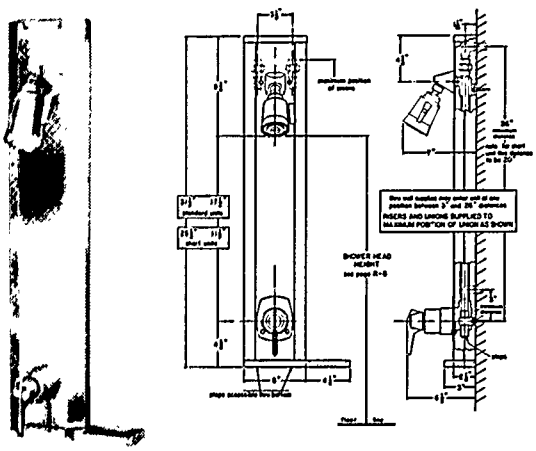


Figure 24. Symmons, "Hydapipe 64." Courtesy of Symmons Indust., Inc.

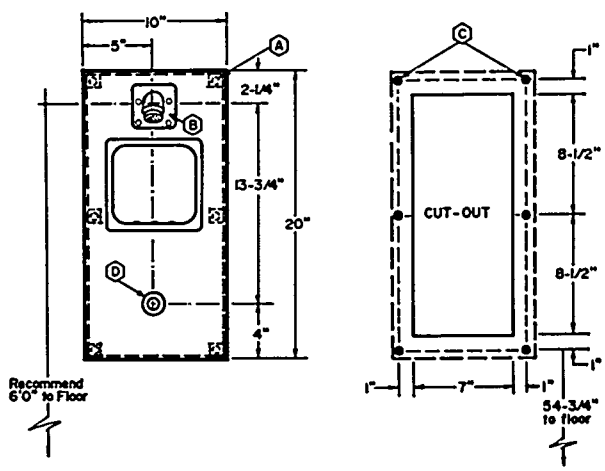


Figure 25. Willoughby, Built-in Panel. Courtesy of Willoughby Indust., Inc.

Shower Control Valves

Control fixtures for public shower facilities are divided into two categories: **Manually controlled,** those allowing temperature and volume to be controlled by the user; and **automatically controlled,** those with the temperature and volume (or duration) preset for the user.

Manual Controls— This type of valve fixture is the simplest to operate and most familiar to the user. It is similar to the compression type valves used in the home shower/bath. Manual controls are available in a variety of designs, ranging from individual hot and cold control valves (fig. 26) to complex mechanical mixers (fig. 27), which combine temperature and volume functions into a single valve assembly. Regardless

of the design, these controls have a common function: They allow the user full to limited control over water volume and temperature. Thus, manual control valves provide the greatest user satisfaction but promote little if any water/energy conservation.

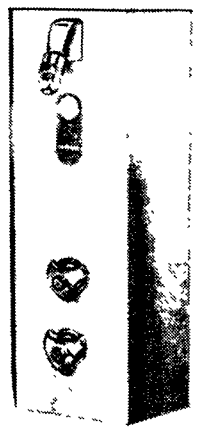


Figure 26. Separate hot and cold valve, panel-mounted unit. Courtesy of Bradley Corporation.

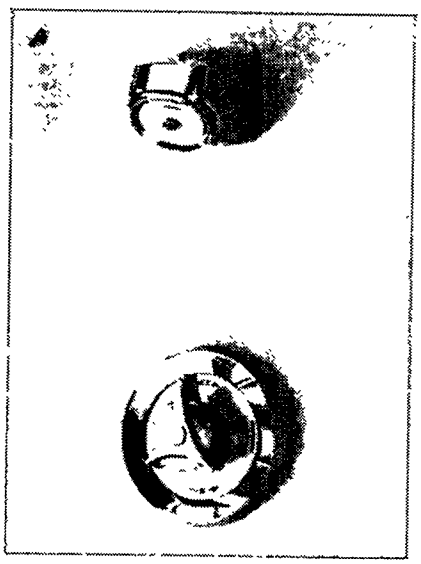


Figure 27. Combination temperature and volume control valve, wall mounted.

Automatic Controls—These fixtures are rarely selected for use in private or home showers. However, they are frequently used in public or institutional facilities (fig. 28). They are restrictive, providing the user with little or no means of customizing the shower to his/her comfort level. However, these fixtures can be preset to meet the needs of a wide range of user preferences and, therefore, they are well suited for public facilities, where operating costs (i.e., water consumption, waste treatment, and heating fuel) are the major administrative concern.

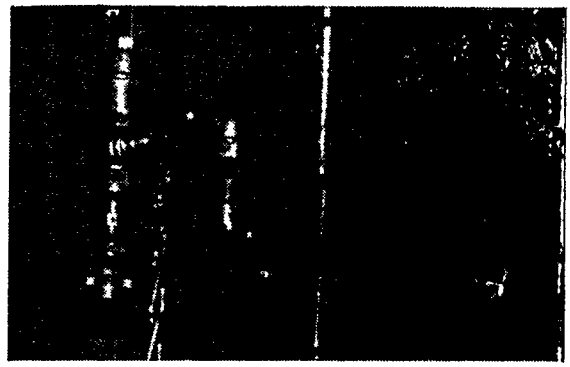


Figure 28. Overhead shower-valve combination, Ozark National Forest.

Flush Valves — This product has been favored in public shower facilities due to its durability and availability of replacement parts. The valves have a lever or push button actuator to trigger the mechanically metered flush valve (fig. 29). The valve assembly can be made vandal-resistant by concealing it behind the shower wall and placing the valve in the adjoining pipe chase storage room which exposes only the lever or push button for the bather to use (fig. 30). The cost of a flush valve with vandal-resistant shower head is about $150.00. Table 4 provides a summary of flush control valves used for shower facilities.

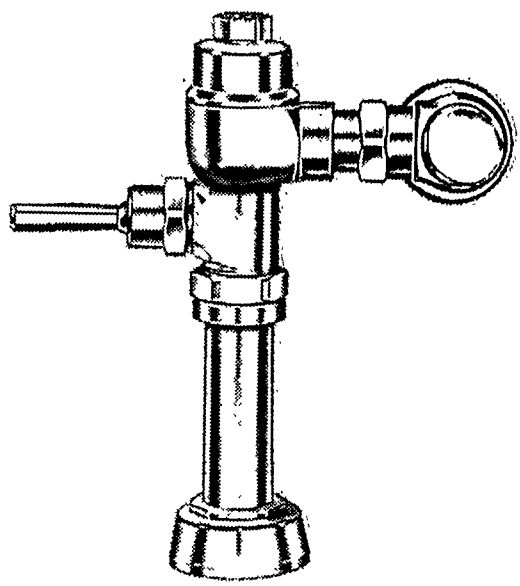


Figure 29. Flush shower valve. Courtesy of Coyne & Delany Company.

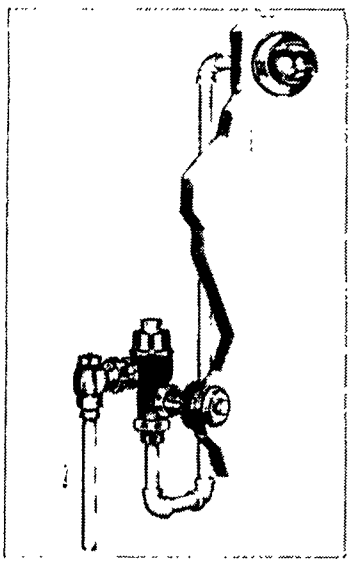


Figure 30. Flush shower system. Courtesy of Sloan Valve Company.

Table 4. Comparison table of flush control valves for public and institutional shower facilities

Mfg.	Model	User force Required (1lb) 1/	Cycle period (sec)	Cost ($) 2/
Coyne & Delaney	Flushboy	3-5	Adjust, 20	105
Sloan	Crown	2.5	Adjust, 30-90	85

1/ Typical user force required to actuate valve when used with 3-in oscillating push button (fig. 31). (Cost for the 3-in oscillating push button is approx $4.00)

2/ These are manufacturer's suggested list prices for 1990 and are subject to change without notice. The prices may not reflect special discounts allowed for Government purchases or large quantity orders.

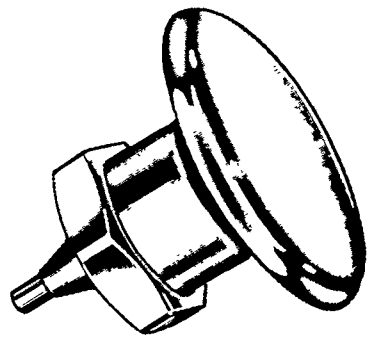


Figure 31. 3-in oscillating push-button. Courtesy of Sloan Valve Company.

Metered or Timed Valves—An alternative to the flush valve, the metered valve (fig. 32), is designed to actuate mechanically, pneumatically, or electronically and then self-close after a set period or cycle. The valves are manufactured with fixed cycles or with field adjustable cycles, ranging from 5 to 60 seconds. Metered valves are generally smaller than flush valves, allowing installation in confined plumbing chases or enclosed in a wall-mounted panel unit (fig. 33). Table 5 provides a summary of selected push button control valves for shower facilities.

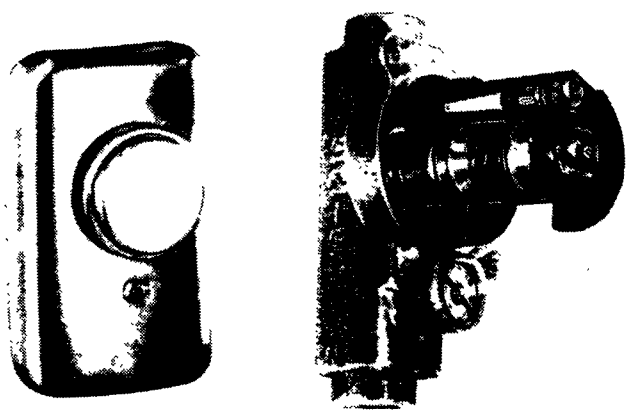


Figure 32. Metered shower control valve. Courtesy of Bradley Corporaton.

without notice. The prices may not reflect special discounts allowed for Government purchases or large quantity orders.

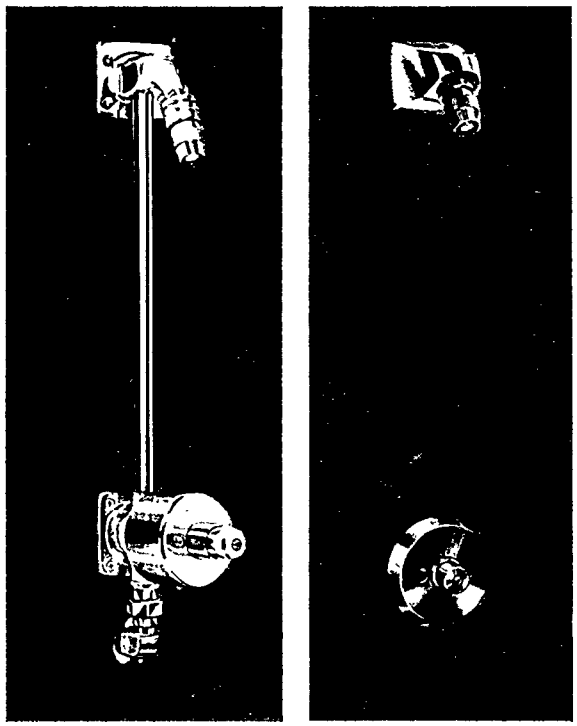


Figure 33. Metered shower system. Courtesy of Symmons Industries, Inc.

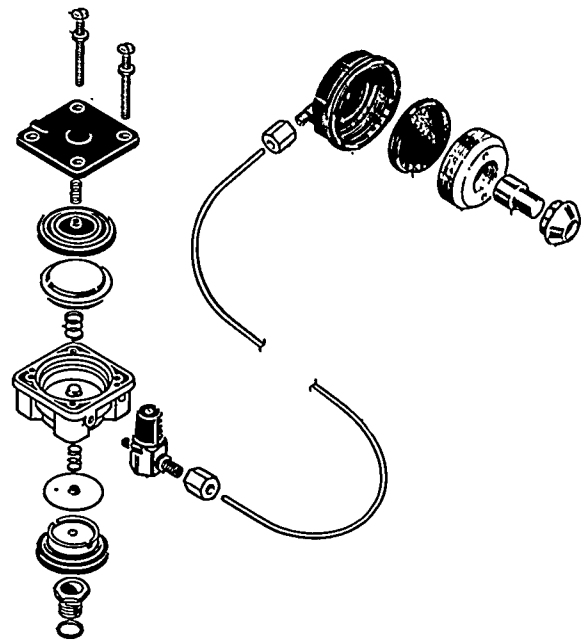


Figure 34. Acorn, "Air-trol." Courtesy of Acorn Engineering.

Table 5. Comparison table of selected push-button, metered control valves for public and institutional shower facilities.

Mfg.	Model	User force Required (1lb) 1/	Cycle period (sec)	Cost ($) 2/
Acorn	Air-trol	4	Adjust, 5-60	110.00
Bradley	Touch'N Flo	4	Fixed, 35-50	135.00
Chicago	776	8	Adjust, 5-15	57.00
Leonard	LV477B	5	Fixed, 30	140.00
Symmons	Showeroff	5	Adjust, 45	150.00
Willoughby	WPPM-2	5	Adjust, 5-90	300.00

1/ Typical user force (lb) required to actuate the valve.

2/ Period on some products may vary, due to water temperature and pressure.

*(**NOTE:** Excessive service line pressures may severely damage or limit the operation of the valve. The manufacturer should be contacted for additional information on line pressure specifications.)*

3/ These are manufacturer's suggested list prices for 1990-91 and are subject to change

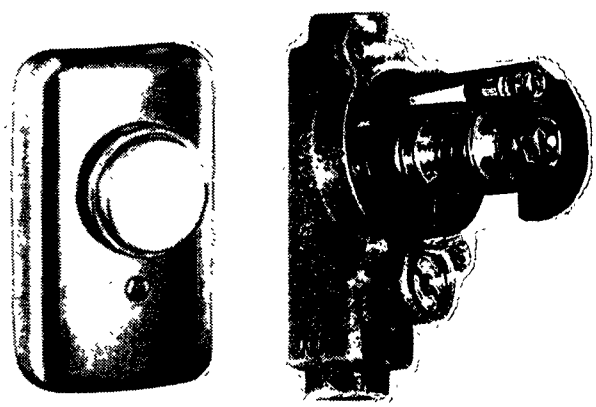


Figure 35. Bradley, "Touch'N Flo." Courtesy of Bradley Corp.

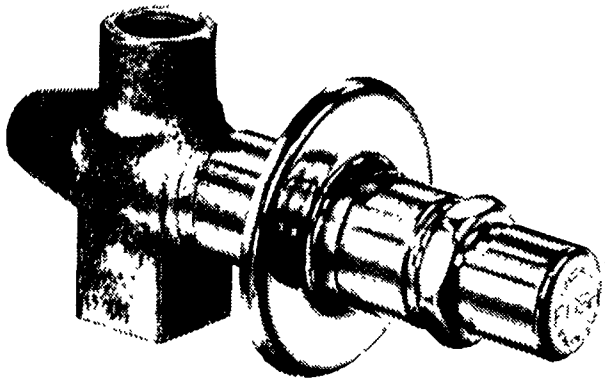


Figure 36. Chicago, model: 776. Courtesy of Chicago Faucet Co.

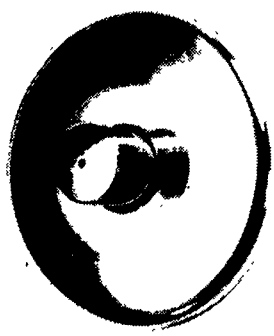


Figure 37. Leonard, model: LV477B. Courtesy of Leonard Valve, Co.

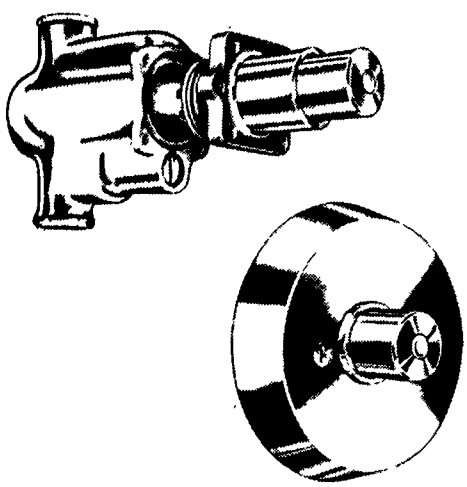


Figure 38. Symmons, "Showeroff." Courtesy of Symmons Ind., Inc.

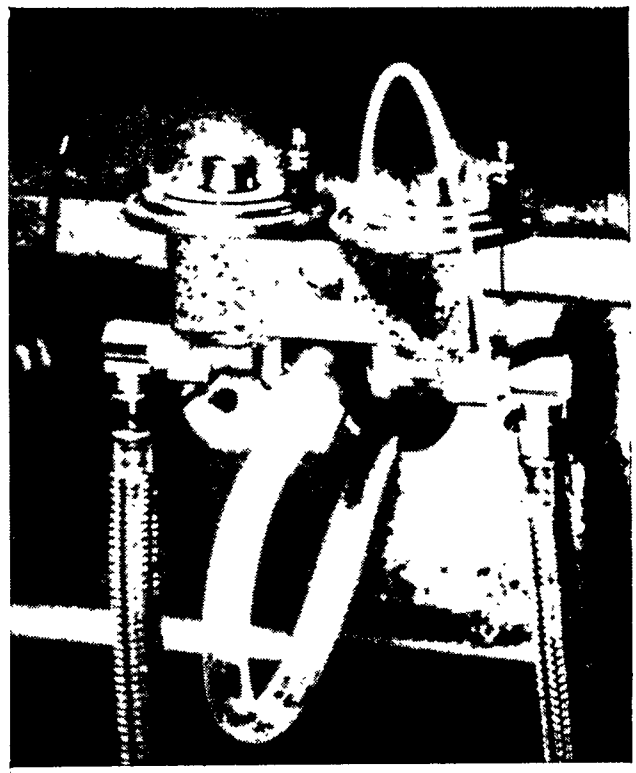


Figure 39. Willoughby, model: WPPM-2. Courtesy of Willoughby Ind., Inc.

Thermostatic Mixer Valves—The automatic control fixture is simply a metered "on-off" valve, without the capability of mixing hot and cold water to a usable temperature. To overcome this, a temperature regulating device or "thermostatic mixer" valve must be installed between the water supply lines and automatic control valve. The mixer valve serves two important functions. First, it regulates the water temperature for the user at a set level selected by the facilities manager. Second, the mixer serves as an anti-scald valve to protect the user during use. The thermostatic mixer senses any sudden change in water supply pressure or temperature (i.e., drop in cold water pressure due to someone flushing adjacent toilets on the same water supply line) and responds by instantaneously adjusting the amount of hot water delivered to the automatic control valve.

To insure that the thermostatic valve operates properly, each mixer valve must be properly sized to the number and type of metered or flush control valve being supplied. Angle checkstop valves must be installed on both inlets of the thermostatic mixer to reduce cross connection between hot and cold supply lines while the metered or flush control valve is not in use. Angle checkstop

valves cost about $75.00 per pair. Table 6 provides a summary of selected thermostatic mixer valves used for shower facilities.

To assist in properly adjusting and monitoring the output temperature, temperature gauges are available. These gauges are convenience items for the maintenance person and allow a one-person operation to adjust the thermostatic mixer valve.

Without the aid of a gauge, the maintenance person would have to have another person inside the shower to feel water temperature while he/she adjusts the thermostatic valve to the desired temperature.

Table 6. Comparison table of selected thermostatic mixer valves for public and institutional shower facilities.

Mfg.	Model	Remarks	Cost ($) 1/
Leonard	Dura-trol	Type TM-25, Model 110B (w/o check stops)	375.00, 86.00
Powers	Hydroguard	Series 420, 430 (25 gpm)	228.00, 354.00
Symmons	TempControl	Model 5-200, 5-400	386.00, 442.00

1/ These are manufacturer's suggested list prices for 1990 and are subject to change without notice. The prices may not reflect special discounts allowed for Government purchases or large quantity orders.

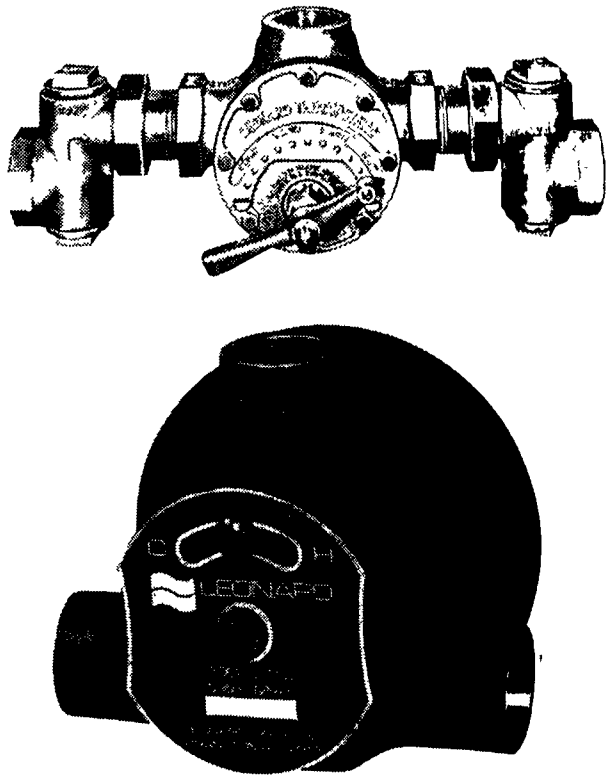


Figure 40. Thermostatic water mixer valve: Leonard, model Type TM w/checkstop valves (top), and model 110 (bottom). Courtesy of Leonard Valve Company.

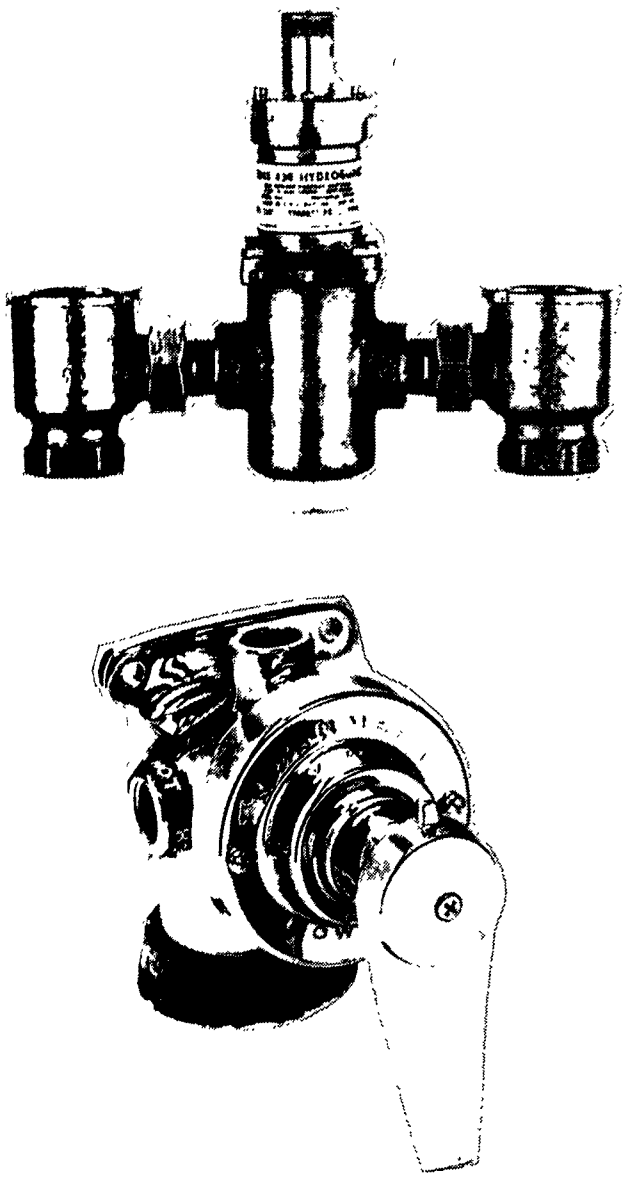


Figure 41. Thermostatic water mixer valve: Powers, Series 430 w/checkstop valves (top), and Series 420 (bottom). Courtesy of Powers Process Controls.

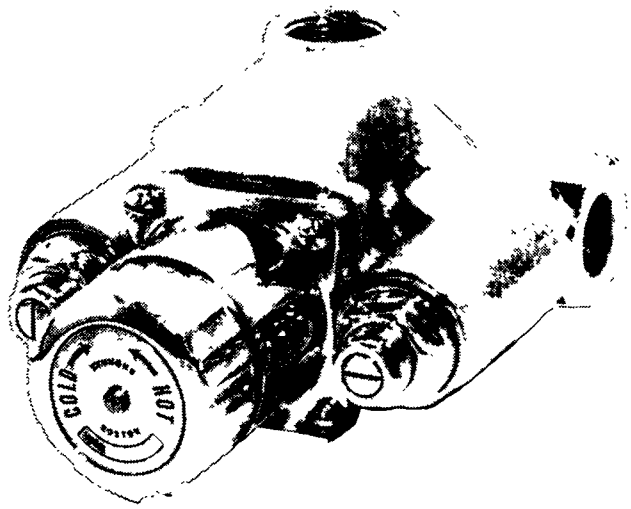


Figure 42. Thermostatic water mixer valve: Symmons, model 5-400 (with integral checkstop valves). Courtesy of Symmons Ind., Inc.

Coin-Metered Controls—Controlling shower use can also be accomplished with a coin operated shut-off valve (fig. 43). The system has worked well in privately owned campgrounds, where the philosophy, "pay-as-you-go" defers a portion of operation and maintenance costs directly to the bather. However, if a coin operated system is used, a reliable source of coins or tokens must be made available for the bather. Change vending machines must be maintained and are easily vandalized in remote unattended sites.

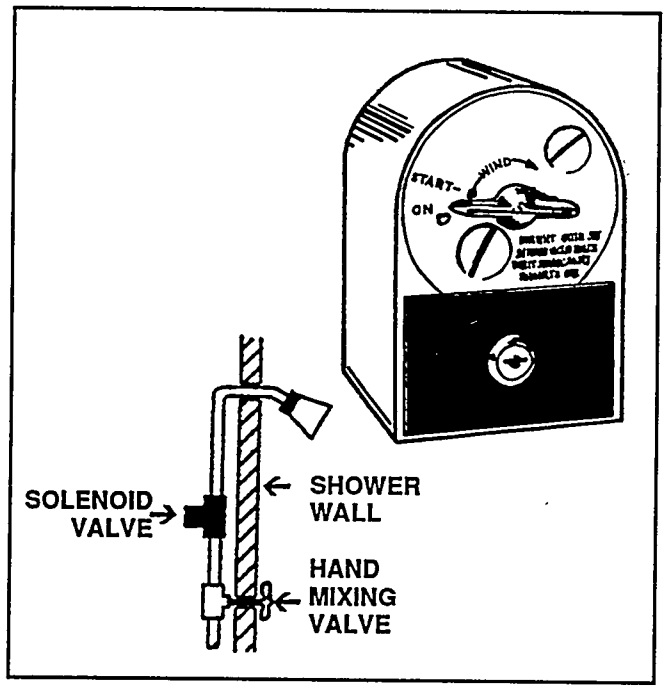


Figure 43. Coin-Metered Control.
Courtesy of Trumbull Recreation Supply Co., Inc.

Shower Heads

Shower heads come in various shapes and sizes, designed to give the user a comfortable experience or conserve water. The conventional household shower head passes water at a rate of 4 to 8 gallons per minute (gpm). Regional water shortages and treatment plant costs have encouraged the development of products designed to limit consumption. Water saver or "low-volume" shower heads have been developed to restrict water flows down to 1.3 gpm. A study conducted by a consumer group concluded the gpm rating claimed by the manufacturer may vary somewhat in actual use, due primarily to variations in line pressure to the shower head. In accordance with industry standards, shower heads advertised as "water-saver" devices must not exceed 2.5- to 3.0-gpm with 25- to 45-lb of line pressure. Though these water saving shower heads have demonstrated benefits in reducing consumption, there is one inherent problem that exists when the flow output is over-restricted. That is, the lower the volume (or restricted flow) the more noticeable the effects of hot water scorching when the cold water pressure suddenly drops (e.g., flushing toilets that are on the same cold water line as the shower system). A thermostatic mixer valve may be needed in the plumbing system to overcome this problem (see prior section on Thermostatic Mixer Valves).

The quality of the shower usually diminishes with restricted water volume. The spray from low-volume fixtures is reduced to a fine mist, something to which many users are unaccustomed. In applications where water pressure is high, the resulting finer spray can feel uncomfortable on the skin. Personal experience has shown that a finer spray tends to take longer to remove soap off the body than a coarse spray, thus the net savings in volume is not as great as one may think. A similar problem can also occur with low-volume water flush toilets, where the user has been observed flushing the toilet several times to adequately clean the fecal material off the bowl. It should be noted, as the quality of experience decreases, the probability of vandalism to low-volume fixtures may increase.

Vandal-resistant shower heads can include any design that is tamper-resistance. Exposed mounting screws, a weak component of shower heads, should be concealed or have a special Allen head set screw. Shower heads with fixed direction and fixed spray pattern provide the least amount of user adjustment and results in the least maintenance.

Some shower heads are designed with a self-cleaning operation (fig. 44 and 45). This type of operation reduces the accumulation of sediment and minerals. In locations, where the water has a high mineral content (high in calcium, magnesium or lime), a self-cleaning feature is preferred.

Table 7 provides a summary of selected shower heads used for shower facilities.

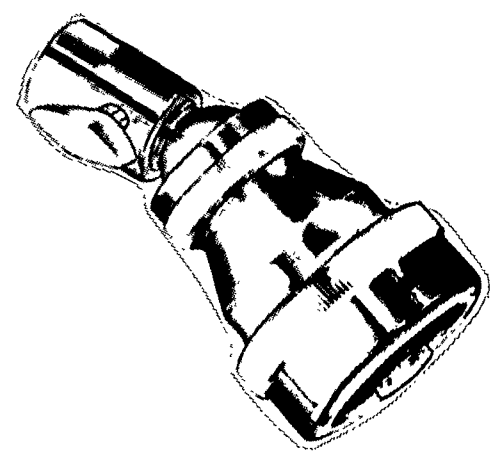


Figure 44. Self-cleaning shower head. Shown here is a Sloan "Act-O-Matic."
Courtesy of Sloan Valve Company.

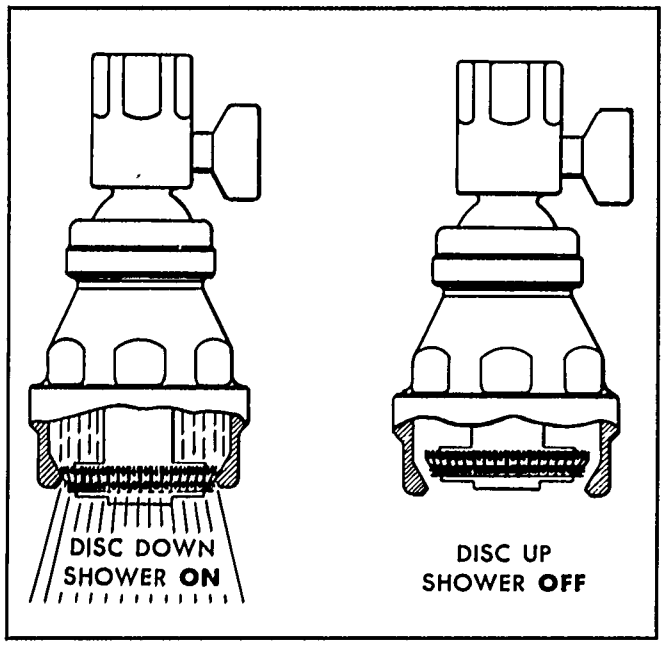


Figure 45. Operation of self-cleaning shower head. Courtesy of Sloan Valve Company.

Table 7. Comparison table of selected shower heads for public and institutional facilities.

Mfg	Model	Self cleaning/ Vandal-resistant	Spray/ Direction	Volume (gpm)	Cost ($) 2/
Bradley	445SX	Yes/Yes	*Fixed/Fixed	2,2.5,3	76
Chicago	621	No/Yes	Fixed/Fixed	2.6	57
Leonard	H-06	Yes/Yes	Fixed/Fixed	2.5	80
Lynnwood	VR-18	Yes/Yes	Adj/Fixed	1.5,2.5	95
Sloan	AC-450	Yes/Yes	Fixed/Adj	3	75
Symmons	4-295	Yes/Yes	Adj/Fixed	2.75,3	81
Willoughby	WSH-3	No/Yes	Adj/Fixed	2.5 1/	75

1/ Volume dependent on control valve volume.

2/ These are manufacturer's suggested list prices for 1990 and are subject to change without notice. The prices may not reflect special discounts allowed for Government purchases or large quantity orders.

NOTE: * Adjustable by maintenance personnel with special tools.

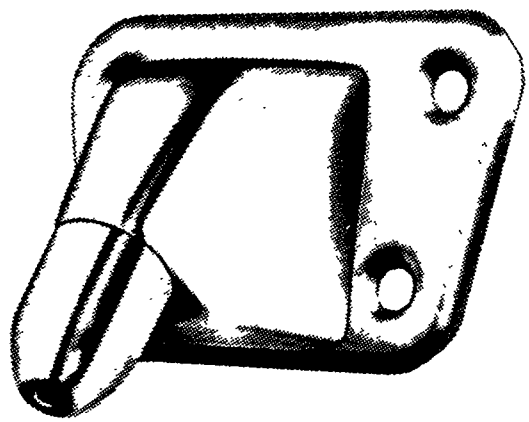


Figure 46. Bradley 445SX. Courtesy of Bradley Corp.

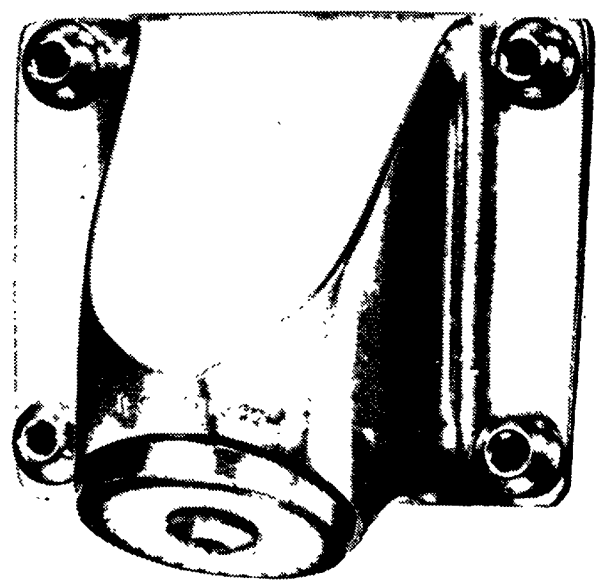


Figure 47. Chicago 621. Courtesy of Chicago Faucet Co.

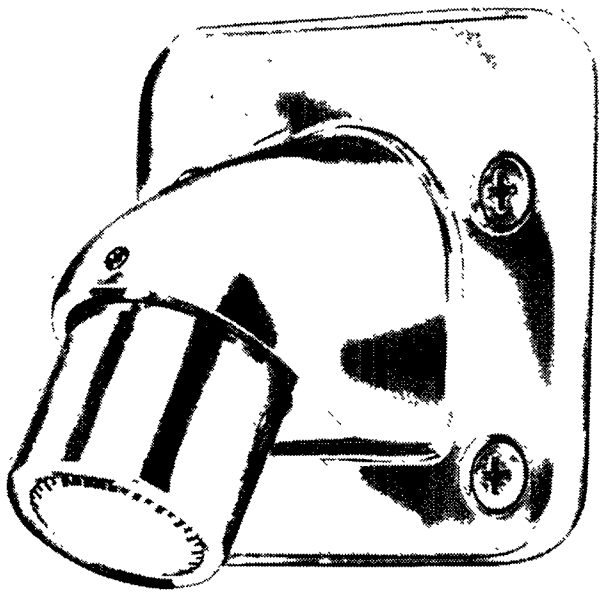


Figure 48. Leonard H-06.
Courtesy of Leonard Valve Co.

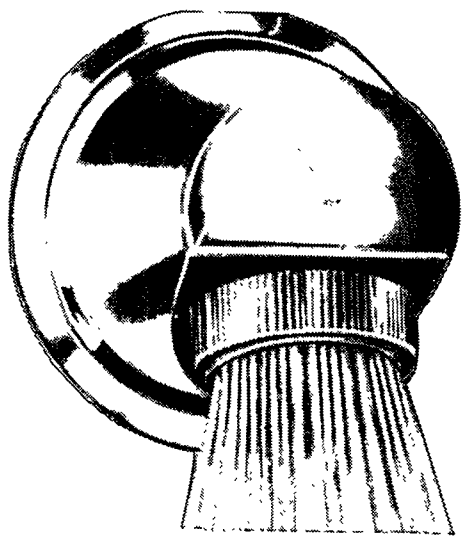


Figure 49. Lynnwood VR-18.
Courtesy of Lynnwood Ind., Inc.

Figure 50. Sloan AC-450.
Courtesy of Sloan Valve Co.

Figure 51. Symmons 4-295.
Courtesy of Symmons Ind., Inc.

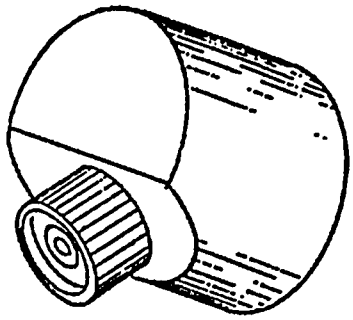


Figure 52. Willoughby WSH-3. Courtesy of Willoughby Ind., Inc.

Water Heaters

There are several methods of heating water to the desired temperature. Depending on energy resources available, i.e., solar, gas (natural or propane), or electricity, the water heater can influence annual operating cost for the entire system.

Types of water heaters:

Electric— These are high energy consumers, usually requiring a 220-volt electrical source and have a slow recovery (time required to heat or recharge the tank to full hot water capacity at the selected temperature setting). The typical tank capacity of electric water heaters required for public showers range from 80 to 120 gallons, depending on use. By comparison, the typical capacity of water heater tanks for the family home is 40-82 gallons. Generally, the recommended sizing for home use is based on 15 to 20 gallons of hot water per person per day (this includes use from wash basins and showers).

Gas (Propane or Natural)—Where such fuel sources are readily available, propane or natural gas heaters can be operated economically. Gas heaters have rapid recovery, in comparison to electric type. But unlike electric heaters, gas heaters produce exhaust that must be insulated and vented out of the building. In remote locations, propane storage tanks can present a problem due to vandalism, leaks, etc.. Provisions for safeguarding against these problems should be considered beforehand.

In appearance, both electric and gas water heaters are very similar to household water heaters (fig. 53). Where space is limited, two or more small water heaters can be installed in tandem to supply an equivalent capacity of a larger single unit. The cost of commercial water heaters can range up to as much as $500.00 or more, depending on size.

In some shower buildings, tank type water heaters may be inappropriate due to infrequent use or limited storage space in the plumbing chase. An option available is to supply heated water by using instantaneous water heaters.

Instantaneous— Also known as "tankless," "in-line," or "on demand" water heaters, these products were developed to conserve energy by heating water only during the period of demand (fig. 54 and 55). This is accomplished by passing the water through heated coils prior to the delivery to the user control valves. The water temperature can be preset at the heater to prevent scalding, thus eliminating the need for expensive thermostatic mixer valves. Instantaneous water heaters can be installed in groups to serve several showers simultaneously. The manufacturer list price for an instantaneous water heater is about $750.00.

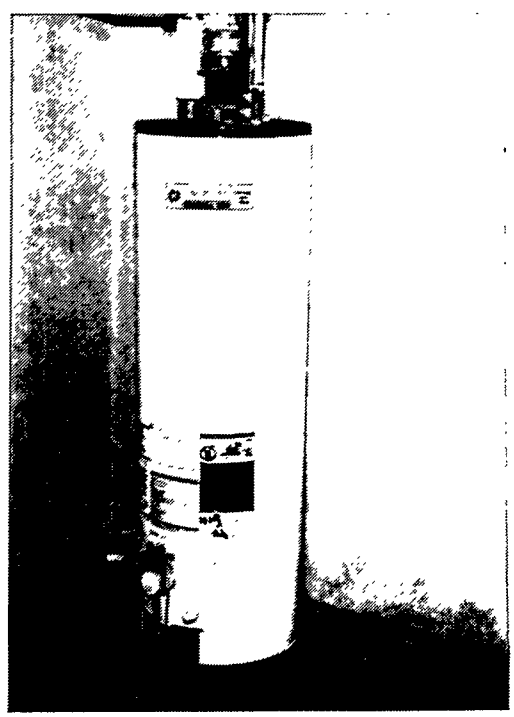


Figure 53. Conventional water heater.

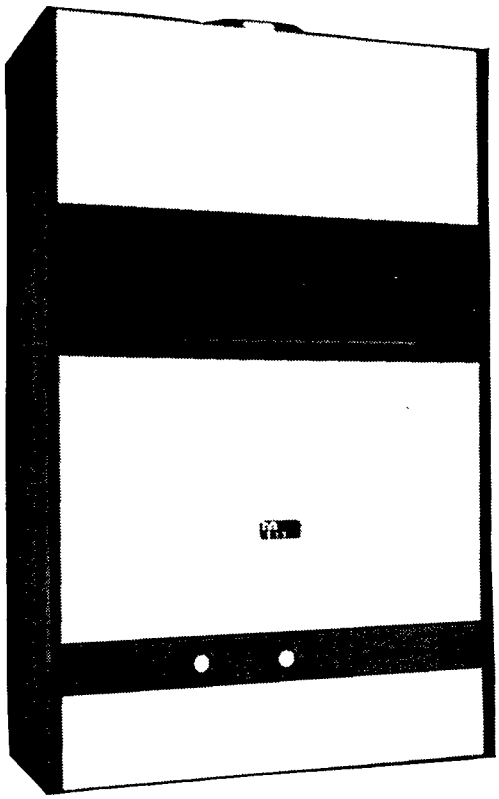


Figure 54. Instantaneous water heater. Aquastar, model 125 VP.
Courtesy of Controlled Energy Corporation.

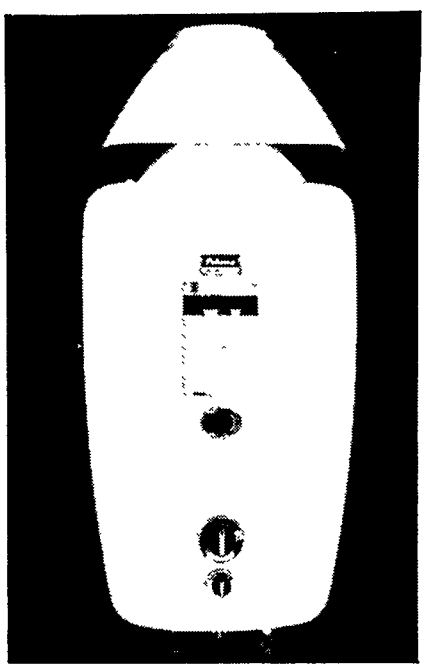


Figure 55. Instantaneous water heater. Paloma, model PH-12M.
Courtesy of Paloma Industries, Inc.

Solar— Another method of heating shower water is by solar energy. Where sunlight is readily available, this method is a inexpensive source of hot water. However, due to unpredictable weather, solar water heating systems serve only as supplements for conventional gas or electric type heating systems.

The operation of solar water heating systems is simple. The components are comprised of a collector and storage tank or water heater (fig. 56). The type of system can either be "open" looped (fig. 57), or direct (where the potable water is directly heated by the collector and transferred to the storage tank); or the system can be "closed" looped (fig. 58), or indirect (where a liquid other than water is circulated through the collector and the heat is transferred to the potable water via a heat exchanger).

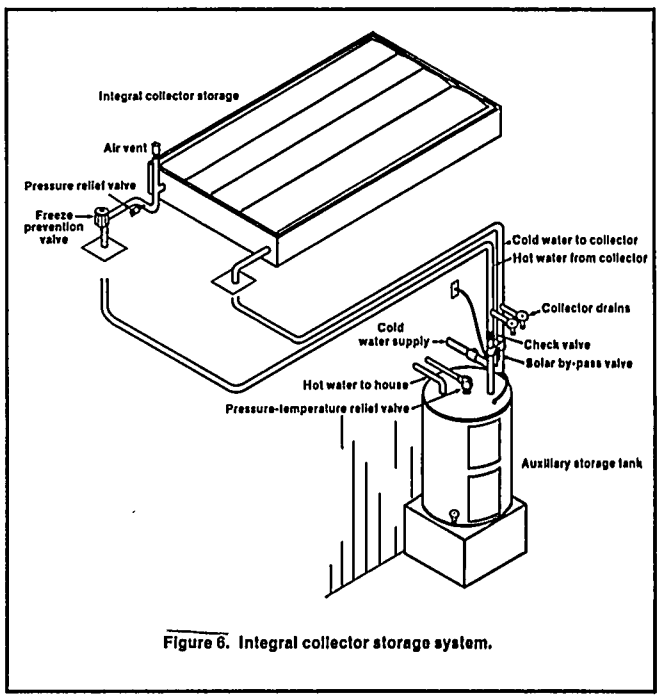


Figure 6. Integral collector storage system.

Figure 56. Typical solar water heater system. [Reprint from Energy Note-Florida Solar Energy Center.]

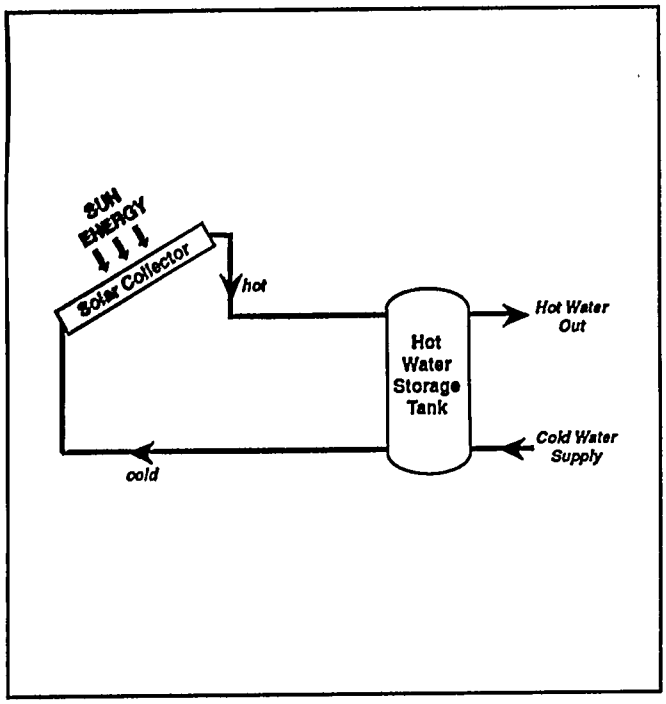


Figure 57. Open-loop system.

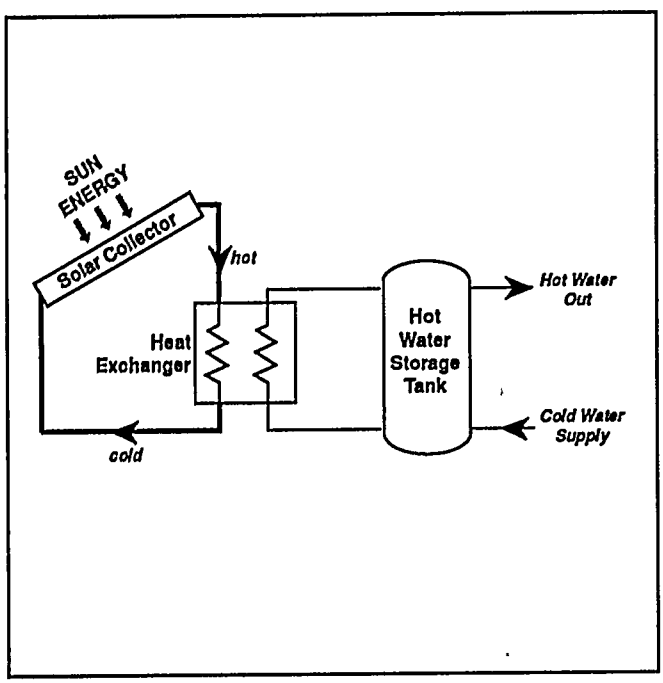


Figure 58. Closed-loop system.

Open loop systems were the typical design used in early development of solar heated water systems. Though this type is the simplest system, it is subject to freezing and special freeze prevention valves, automatic recirculating pumps or winterization is required in those areas that freeze.

Close loop systems can overcome the effects of freezing by using an antifreeze liquid, since the circulating system is isolated from the potable water. This allows wider range of application in cooler climates.

The movement of liquids in the solar heated system can either be active (with aid of a pump) or it can be passive (without mechanical assistance, using a principle called thermosiphoning).

The method of mounting the collector unit is an important consideration. Maximum heat absorption or efficiency is obtained when the face of the collector is at maximum incidence (or perpendicular) with the sun's rays. For summer use, most building roofs have adequate tilt angle to allow mounting the collectors parallel with the roof surface. However, the building must be oriented so the roof mounting plane is facing due south (fig. 59a). For retrofitting existing facilities, poor building orientation and weak structural support prevents the application of roof mounted collectors. The alternative method is to mount the collector on the ground and protected within an enclosed area (fig. 59b).

Figure 59a. Solar heated shower building, retrofitted with multiple heat collectors, California State Parks.

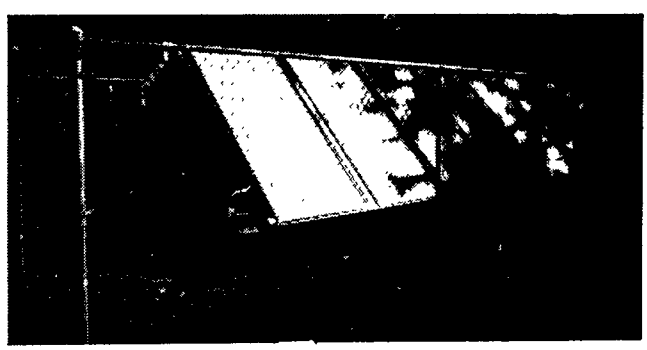


Figure 59b. Ground mounted solar heat collectors, California State Parks.

SUMMARY GUIDELINES FOR SHOWER FACILITIES

The following summary include general tips to consider in designing public shower facilities:

1. Shower facilities consume enormous resources (maintenance cost, water, heating energy, sewage disposal, and administration cost). These factors should be thoroughly assessed against the benefits of providing such facilities.

2. Accessibility consideration should be the priority. Access considerations should consider all impairments (visual, hearing, etc.) in addition to immobility.

3. Select a building design that best meets the customer's need. Separated gender shower buildings have been the tradition but provide least privacy for the user. Unisex showers can enhance the capacity or movement of users during peak use and best accommodates people with disabilities.

4. Floor appearance is the most important item to the user. Floor slope, coved floor corners, and numerous floor drains helps to facilitate the removal of water and reduces cleaning time.

5. Amenities such as interior benches, waiting benches, clothes hooks and shelves help to accommodate the user. These amenities should be functional as well as aesthetic.

6. Select a shower plumbing system (controls, water heaters and shower head) that best meets the building design and is simple to maintain. A functional shower system should have hardware that is familiar to the user; requires minimal maintenance and is simple to repair (i.e., least mechanical parts and readily available replacement parts) by maintenance personnel; and promotes conservation of energy and water resources.

7. Water conservation is the key factor in reducing operating costs. Selecting the appropriate water saving fixture (shower heads, metering valves, etc.) can assist in reducing consumption. Many urban areas have already begun the process of educating the public in energy and other resource conservation needs. This effort should be reinforced at all public shower facilities by positive signing, which conveys the message of conserving water, electricity, etc. Do not overlook other methods that contribute to conserving energy such as installing insulating jackets on water heaters and hot water supply lines.

8. Vandalism must be considered into the facility design and selection of hardware. If excessive vandalism is anticipated, it may be more beneficial to select hardware that is simple, inexpensive, and easily replaceable. Note: floor vents made of louvered aluminum are targets for vandals. Specifying a durable heavy gauge expanded metal screen easily solves this problem. Perhaps the greatest deterrent to vandalism is the presence of an on-site facility manager (Campground HOST).

9. The maintenance program should emphasize an ample supply of replacement parts/hardware to keep the facility operational. A routine preventative maintenance schedule is part of maintenance.

RECREATIONAL VEHICLE SANITARY DUMP STATIONS

Customer Needs

A survey of recreational vehicle (RV) trailer and motor home manufacturers indicated a standardized placement and design of sewer cleanout on both trailers and motor homes. The sewer drain accepts a standard 3-in diameter flexible hose and is located on the driver side of the vehicle. The height of larger motor homes approach 12-ft, with lengths up to 40-ft and widths up to 8-ft. The sewage holding capacity can range up to 100 gallons, combining black water (toilet sewage) and grey water (sink and shower liquids). Generally, the total sewage holding capacity is slightly above the capacity of the potable water tank, to prevent overflow.

The procedure typically used to empty the holding tank(s) include:

1) The vehicle drain hose is attached to the waste drain connection of the RV trailer or motor home; the other end of the hose is inserted into the dump station sewage drain. The flexible drain hose is typically 10-ft in length and stored inside the rear bumper or storage compartment provided near the sewage drain of the trailer or motor home.

2) Then, the tank containing raw sewage (commonly referred to as the "black" water waste) is drained.

3) After draining the raw sewage, the black water drain valve is closed, and the drain valve for the sink/bath waste (commonly referred to as "grey" water waste) is opened, flushing any black water residue through the hose.

4) Finally, the drain hose is disconnected and flushed with a garden hose normally provided at the dump area.

Treatment of the holding tank waste with chemical or biological products has been a common practice for reducing noxious septic odors or for liquefying sewage wastes. The manufacturers of chemical products, in the last several years, have reduced their reliance on formaldehyde additives. Formaldehyde is a bacteriostat that has been found to be a suspected carcinogen. However, about 10 percent of the products on the market still rely on formaldehyde additives to control odor. Because there is little control on the use of chemical additives, municipal treatment plants are reluctant to accept waste from sanitary dump stations.

Waste treatment will not be covered in this report. We recommend the local sanitary engineer be contacted regarding acceptable waste disposal methods.

Design and Maintenance Considerations

Design

The sanitary dump station must accommodate vehicles ranging in lengths of up to 40-ft, plus a tow vehicle. In most designs, the station should accommodate the concurrent servicing of two vehicles. The additional accommodation will provide a back-up, in the event one service unit must be closed for maintenance or unplanned repairs. The basic requirements for a dump station include:

1) Sewage drain

2) Non-potable water—for cleanup around the sewage drain and flushing drain hose

3) Potable water—for refilling fresh water storage tanks.

4) Garbage cans for solid waste.

An important item not to be overlooked is the proper designation of potable and non-potable water faucets or hydrants. The two must be clearly identified to prevent accidental contamination of the RV's water supply. Though the two faucets are on the same service line, the source of contaminant arises from the cleaning hose provided at the sewage drain, that may be used to fill RV water tanks unless separate potable water faucets are provided. The recommended site distance between potable and non-potable faucets is 40-60 feet. Backflow preventers are necessary at the cleaning hose location.

Maintenance

A properly designed station will require minimal maintenance. In cooler climates, annual winterization will be a standard maintenance practice.

The concrete apron around the sewage drain is porous and absorbs bacteria. The concrete should be periodically coated with a concrete sealant and heavily sloped to prevent accumulation of any liquid.

Access for People with Disabilities

New products are continually being developed to meet the changing public needs. The latest product to be developed is the "telescoping" drain. This device is permanently mounted to the RV's sewer drain, eliminating the messy job of connecting hoses. The attachment allows a simple one-hand operation as the user extends the telescoping pipe out to the dump station sewage drain.

There are no accessible guidelines specific to RV sanitary dump stations. However, those UFAS specifications applicable to mechanical controls and surface grades must be applied.

Common access problems observed in existing designs:

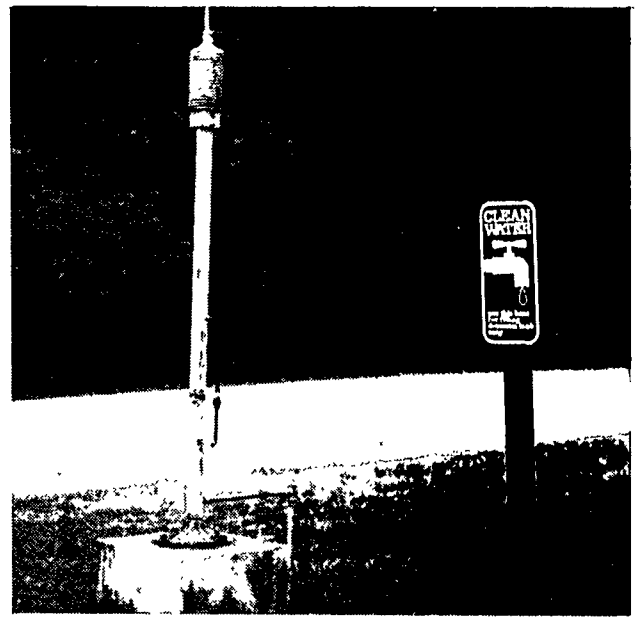
- inaccessible water towers (fig. 60a) - curbs or other barriers obstruct access to water towers and hose bibbs.

- inaccessible foot actuated sewage caps (fig. 60b) - the foot pedal cap is difficult to open for a person with mobility impairment. Rocks are often used to prop the cap open and can create a hazard for the user.

- inaccessible water tower and hose bib valves - UFAS requires all controls be operable without excessive grasping or twisting.

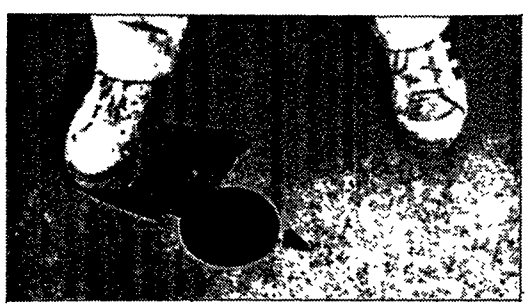
- inconsistent signing - signs should be simple, legible and readable from a distant (fig. 61). For visually impaired people having limited vision, contrasting colors (dark and light) are more recognizable than the color themselves. Color coding the water hydrants (fig. 62) at the sanitary dump station is one method of identifying potable and non-potable water sources.

Non-accessible

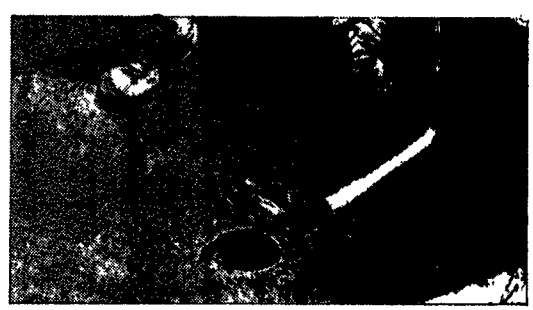


Non-Accessible

Figure 60a. Accessibility considerations.



Non-accessible



Accessible

Figure 60b. Accessibility considerations.
Courtesy of Formrite Tube Co.

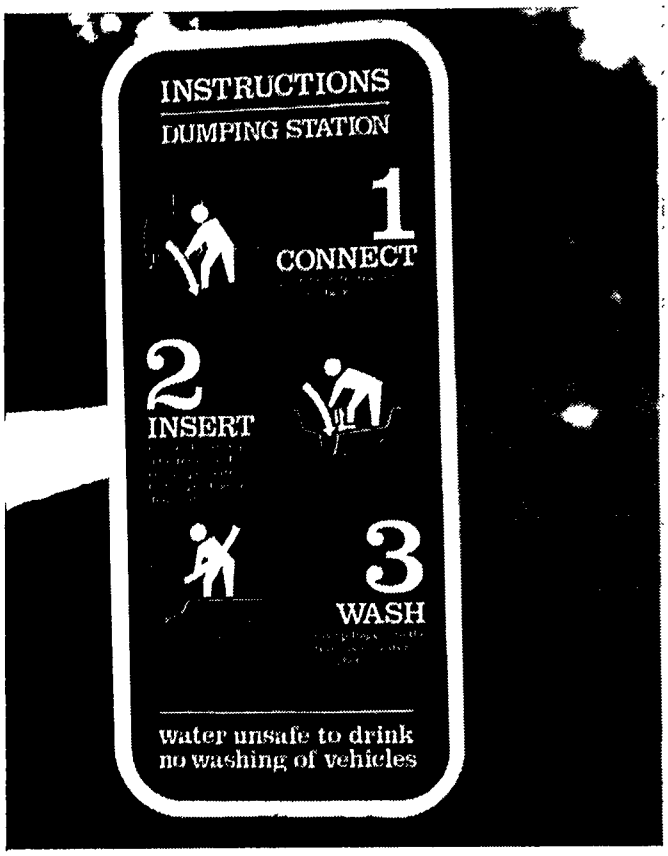


Figure 61. Simple to follow instructions.

Figure 62. Potable water source separated away from sewage drain area. Painting the non-potable tower "red" and potable tower "green" helps distinguish the two.

*(**NOTE:** When selecting colors for accessibility consideration, contrasting shades [i.e., light and dark] are more important than the colors themselves.)*

Water Towers

The plumbing fixture commonly used for dump stations is the Romort water tower (sometimes referred to as a "culinary" fixture). The fixture (fig. 63) was originally designed as an air dispensing tower for gas stations but was later adapted to its current application for sanitary dump stations. The water tower is manufactured by the Formrite Tube Company, currently the only company specializing in this type of dump station fixture.

A field inspection of several older Romort towers identified problems that have been corrected in the newer model. In the older design, the flexible hose was not shielded, consequently, the prolonged abrasion with the spring assembly required frequent replacement of the hose. Another problem observed, especially at sites with heavily mineralized water, is a malfunctioning vacuum breaker valve. This valve prevents any contaminated water from siphoning back into the water system when the water is shut off (fig. 64).

Figure 63. Water tower.
Courtesy of Formrite Tube Co.

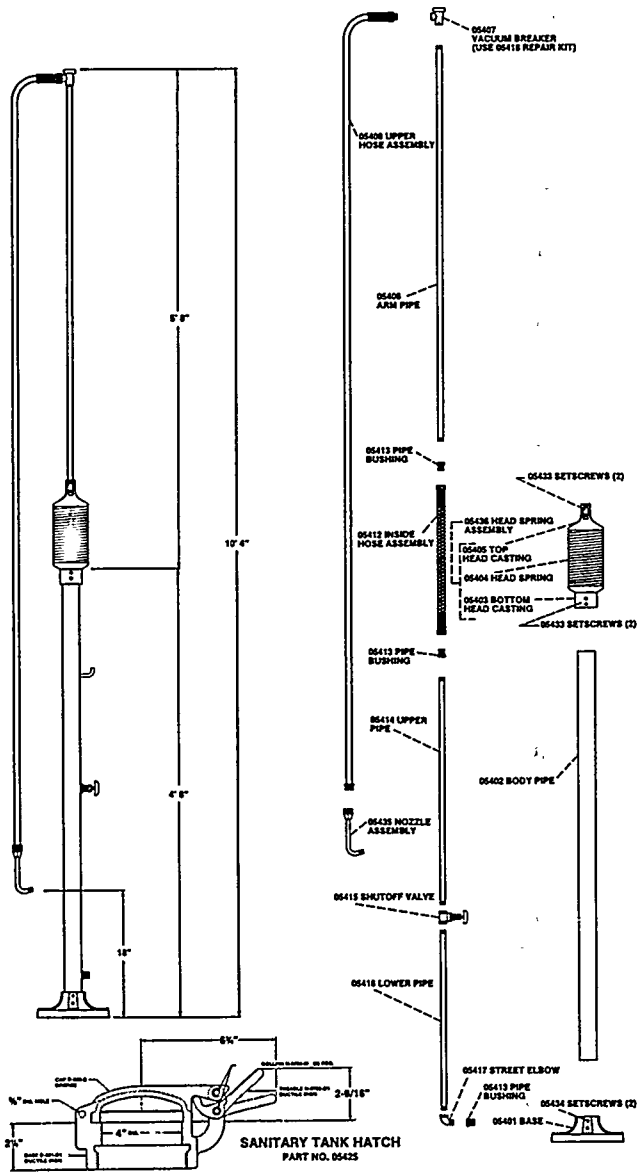


Figure 64. Formrite (Romort) Water Tower. Courtesy of Formrite Tube Co.

SUMMARY GUIDELINES FOR RECREATIONAL VEHICLE SANITARY DUMP STATIONS

1. The method planned for treatment of the sewage must be established prior to the installation of any sanitary dump station facility. Local sanitary engineers must be consulted early into the planning process.

2. Accessibility for people with disabilities must be incorporated in the construction of all new facilities. Accessible curbing, accessible water hydrants and controls valves, and accessible sewage drain covers must be made available to the public.

3. Accommodation for recreation vehicles with tow vehicles must be considered as well as planning for the direction of flow for vehicular traffic. Uniform traffic signs and directional arrows painted on the road surface can reduce confusion.

4. No facility is maintenance free. Surface sealants must be applied periodically to the concrete apron around the sewage drains. Hydrants, both potable and non-potable sources, must be inspected to assure the backflow devices are functioning.

RECREATIONAL VEHICLE ELECTRICAL SERVICE EQUIPMENT

Customer Needs

The typical recreational vehicle (RV) travel trailer or motor home is equipped with all the comforts of home. Fully equipped with a television, video recorder, sound entertainment system, microwave oven, air conditioner(s) and lights, the peak power demand from a single RV site hookup can be quite high.

Fortunately, consumption is limited by the size of circuit breakers provided in the RV unit. Standard circuit breakers limit consumption to 20 or 30 amps (equivalent to 3.6 kilowatts of power). Circuit breakers are provided to protect the wiring from over heating and causing a fire within the vehicle.

The National Electrical Code (NEC) provides standards for installation of all electrical service equipment, and it is sponsored by the National Fire Protection Association, under the auspices of the American National Safety Institute (ANSI). The Code is purely advisory and offered for use in law for State and local agencies, who have the option of adopting the NEC in its entirety or supplement it with additional restrictions.

The NEC provides specific application for equipment design, specifications and wiring calculations for RV's and RV parks (Article 551 - Recreational Vehicles, Parks).

*(**Note:** the NEC is periodically updated to reflect changing technology and safety considerations. Current national and local requirements should be investigated to assure compliance.)*

For RV vehicles, the 1990 NEC requires:

Article 551-46. Means for Connecting to Power Supply.

(b) Cord. The cord set shall be approved for use with recreational vehicles. The cord shall

be not less than 20 feet as measured from the point of entrance to the recreation vehicle or the face of the motor-base attachment plug nor more than 26-1/2 feet in length overall to the face of the attachment plug at the supply end.

Design and Maintenance Considerations

Design

Electrical components and hardware must be listed with a certified testing institution or company, such as Underwriters Laboratories (UL).

Two types of wiring systems are common in RV parks or campgrounds: 1) Radial-feed system (fig. 65); and 2) Loop-feed system (fig. 66).

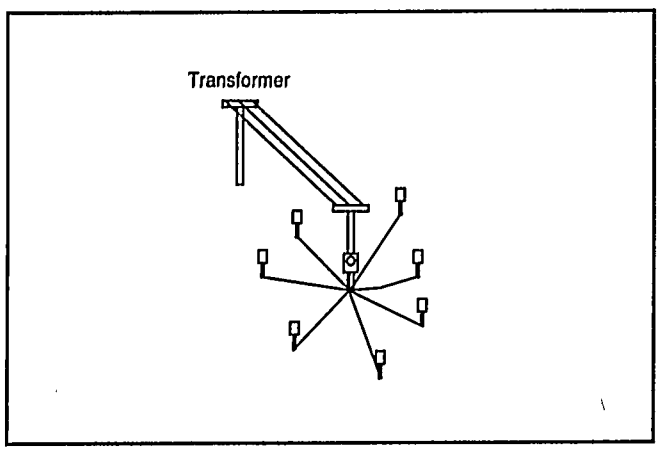


Figure 65. Radial-feed system.
Courtesy of Midwest Electric Products, Inc.

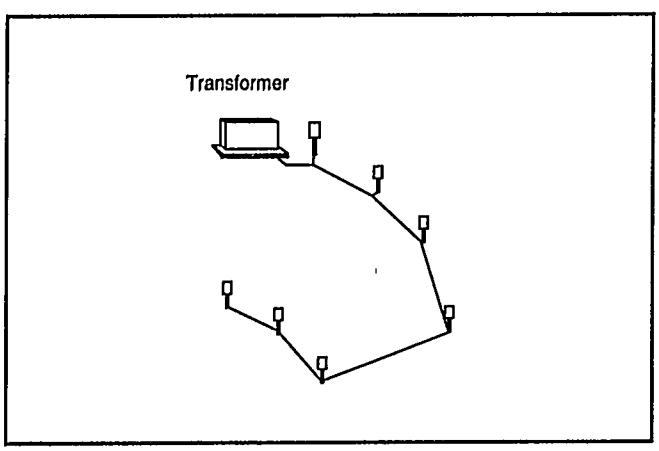


Figure 66. Loop-feed system.
Courtesy of Midwest Electric Products, Inc.

The loop-feed system is the most economical, requiring less wiring. It allows greater site administration by controlling power to individual camping loops—an important consideration when conducting maintenance or emergency repairs.

In RV Parks, the 1990 NEC requires:

Article 551-76. Recreational Vehicle Supply Equipment.

(a) Location. Where provided, the recreational vehicle site electrical supply equipment shall be located on the left (road) side of the parked vehicle, on a line which is 9 ft, + one foot, from the longitudinal centerline of the stand (parking pad) and shall be located at any point on this line from the rear of the stand to 15 ft forward of the rear of the stand.

(b) Disconnecting Means. A disconnecting switch or circuit breaker shall be provided in the supply equipment for disconnecting supply to the recreational vehicle.

(c) Mounting Height. Site supply equipment shall be located not less than 2 ft nor more than 6-1/2 ft above the ground.

Article 551-79. Clearance for Overhead Conductors. Open conductors of not over 600 volts, nominal shall have a vertical clearance of not less than 18-ft and a horizontal clearance of not less than 3-ft in all areas subject to recreational vehicle movement.

In forested areas, overhead wiring should be avoided due to visual and safety reasons and the associated maintenance costs required for vegetative clearing and fire-proofing.

Article 552-80. Underground service, feeder, branch-circuit and Recreational Vehicle Site Feeder Circuit Conductors.

(b) Protection Against Physical Damage. Direct buried conductors and cables entering or leaving a trench shall be protected by rigid metal conduit, intermediate metal conduit, electrical metallic tubing with supplementary corrosion protection, rigid nonmetallic conduit or other approved raceways or enclosures. Where subject to physical damage, the conductors or cables shall be protected by rigid metal conduit. All such protection shall extend at least 18-in into the trench from finished grade.

Maintenance

Maintenance should include frequent checking of the Ground Fault Interrupter (GFI) system of each site supply. Damaged receptacles and circuit breakers should be referred to a licensed elec-

trician. Emergency shut-off breakers should be clearly marked and operating procedures discussed with campground personnel, including campground HOSTs (fig.67).

Ground mounted power transformers should be inspected frequently to be sure protective enclosures are secured and locked.

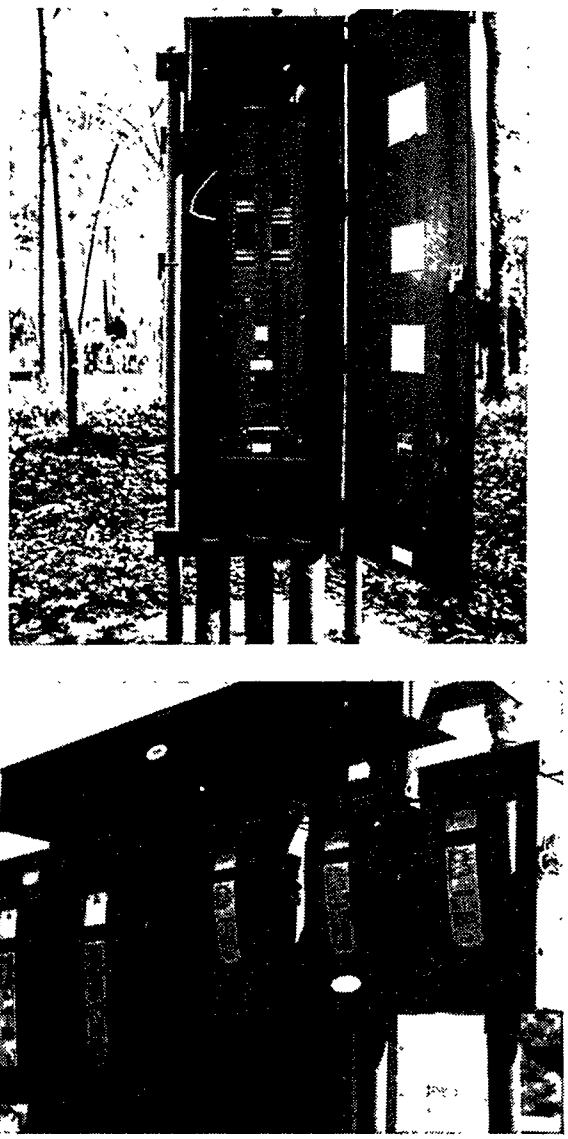


Figure 67. Distribution enclosures.

Access for People with Disabilities

There are no accessibility guidelines specific to RV electrical service hookups. However, such UFAS specifications applicable to mechanical controls, fixture height, ground surfacing and surface grade must be applied (fig. 68).

Common access problems observed in existing designs:

- inaccessible ground surface - the electrical service equipment is often located on unpaved surfacing several feet from the paved vehicle parking pad.
- inaccessible circuit breakers or control switches - UFAS requires all controls be operable without grasping or twisting and with less than 5-lb force.

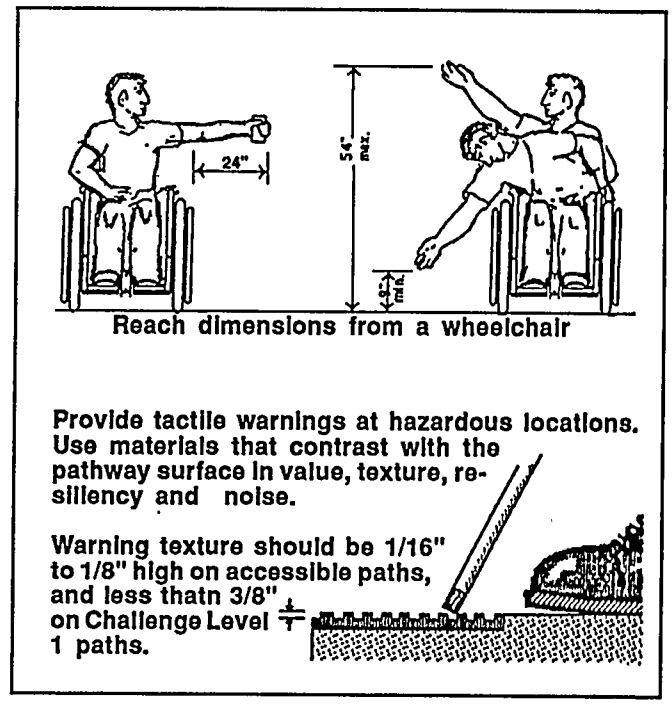


Figure 68. Accessibility considerations. [Reprint from Design Guide for Accessible Outdoor Recreations.]

Service Equipment Enclosures, Receptacles, Accessories

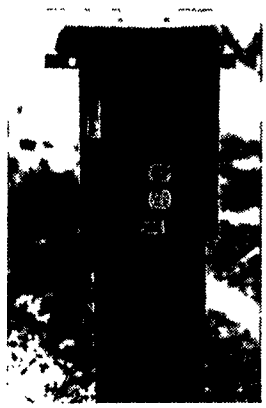
Enclosures

Enclosures are available in two types of material (fig. 69): 1) metallic (usually made of a zinc coated steel with a painted or anodized finish); 2) non-metallic (usually a thermoplastic or polycarbonate "Lexan" material. Mounting is either pedestal—fastened directly to a concrete slab; or post mounted (attached to a wooden support or metal pole). Non-metallic enclosures are generally required for applications such as marinas. Enclosures are also available with special multifunctional service features such as electrical, TV, telephone, sewer and water hookups, all enclosed in a single pedestal unit.

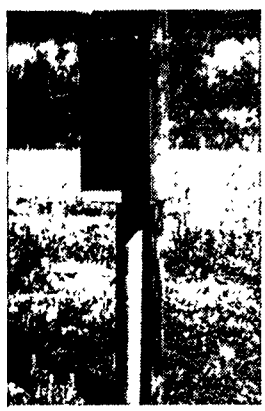
All enclosures should meet National Electrical Manufacturing Association (NEMA) standards. Enclosures of the NEMA type 3R construction, provide assurance that the installation will be weatherproof, especially against rain.

The doors normally include a stay-open feature for user convenience. This feature can assist disabled users by allowing one-hand operation.

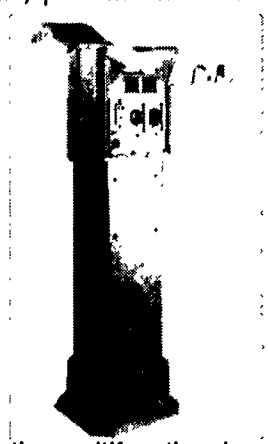
In outdoor applications, the door should be convexed or molded with sufficient depth to allow complete door closing, even with the user's supply cord inserted into the receptacle, a feature distinguishing RV enclosures from other applications. The bottom edge of the door should have a rolled edge for user safety and cord protection.



Metallic, pedestal mounted enclosures.



Metallic, post mounted enclosure.



Thermoplastic, multifunctional enclosure.

Figure 69. Enclosures.
Metallic, thermoplastic, multifunctional enclosure, courtesy of Midwest Electric Products, Inc.

Receptacles

In RV park application, the 1990 NEC requires:

Article 551-71. Type Receptacles Provided. Every recreational vehicle site with electrical supply shall be equipped with at least one 15- or 20-ampere, 125-volt receptacle. A minimum of 75 percent of all recreation vehicle sites with electrical supply shall each be equipped with a 30-ampere, 125-volt receptacle conforming to Figure 71. This supply shall be permitted to include additional receptacle configurations conforming to section 551-81 (NEC). The remainder of all recreational vehicles sites with electrical supply shall be equipped with one or more of the receptacle configurations conforming to section 551-81.

All 15- or 20-ampere, 125-volt receptacles shall have listed ground-fault circuit-interrupter protection for personnel. Additional receptacles shall be permitted for the connection of electrical equipment outside the recreation vehicle within the recreational vehicle park, and all such 125-volt, single-phase, 15- and 20-ampere receptacles shall have ground-fault circuit-interrupter protection for personnel.

Additional receptacles shall be permitted for the connection of electrical equipment outside the recreational vehicle within the recreational vehicle park (fig. 71). All such 125 volt, single-phase, 15- and 20-ampere receptacle shall have ground fault circuit interrupter protection for personnel.

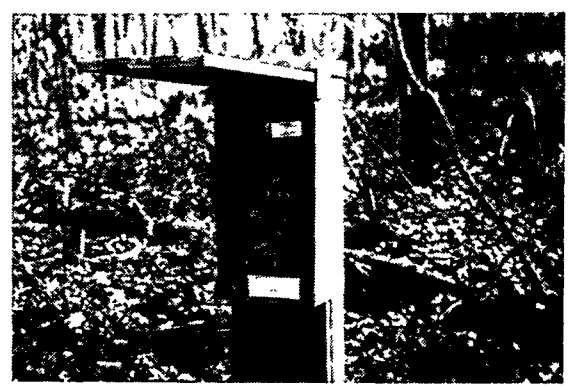


Figure 70. Typical RV electric service, shown in pedestal mount with single 20-ampere standard and dual 30-ampere RV receptacles.

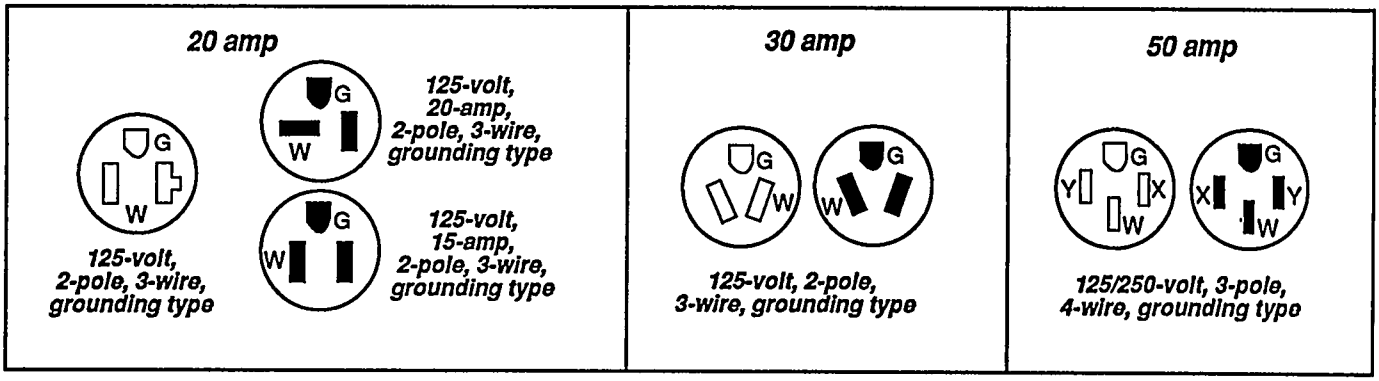
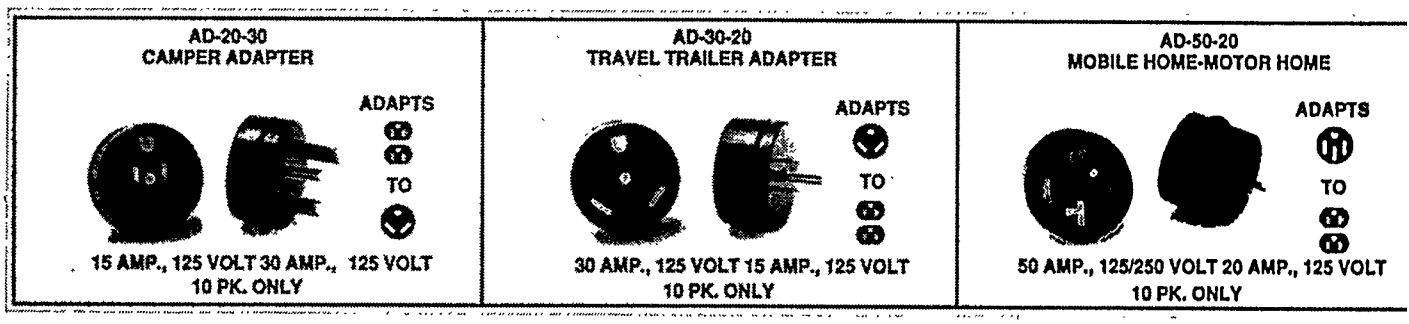


Figure 71. Receptacles. [Reprint from NEC, Figure 551-46(c)]

Accessories

Due to the variation in receptacles, as described in NEC's Figure 551-15(c), adapters (fig. 72) have been devised to overcome the difficulty of interfacing. These adapters are typically carried by the user or usually made available for a fee at the campground.



Camper adapter | Travel trailer adapter | Mobile home or motorhome adapter

Figure 72. Accessories. Courtesy of Midwest Electric Product, Inc.

SUMMARY GUIDELINES FOR RECREATIONAL VEHICLE ELECTRICAL SERVICE EQUIPMENT

1. The NEC provided in this document has not been adopted by all States. For this reason, a licensed contractor familiar with the local codes applicable to the site should be consulted.

2. Public safety should be the primary focus in maintaining electrical service equipment. The facility must have a safety plan which clearly identifies emergency power shut-off equipment and trained personnel (i.e., campground Hosts, site attendant, etc.) who can respond quickly to any electrical problem.

3. Accessibility for people with disabilities must be incorporated in the construction of all new facilities. Accessible electrical service enclosures and circuit breakers must be made available to the public.

4. Electrical service hookups must accommodate the power demand of the user. Recreational vehicles equipped with air conditioners consume far more power than the average tent camper will ever use. Methods for equitably charging the user may be necessary at some sites.

APPENDIX I

List of Manufacturers and Products

Manufacturer	*Product*
SHOWER PLUMBING FIXTURES	
Acorn Engineering Company P.O. Box 3527 City of Industry, CA 91744 818/336-4561	• engineering design service • manual control valve • metered control valve • thermostatic mixer valve • recessed service faucet box
Bobrick Washroom Equipment, Inc. 11611 Hart Street North Hollywood, CA 91605 818/764-1000	• stainless steel shelf • stainless steel grab bars • stainless steel waste container • stainless steel clothes hook • stainless steel soap dish • waterproof shower seats
Bradley Corporation P.O. Box 309 Menomomee Falls, WI 53051 414/251-6000	• engineering design service • manual control valve • metered control valve • thermostatic mixer valve • shower head • hand showers
Chicago Faucet Company 2100 South Clearwater Drive Des Plaines, IL 60018 312/694-4400	• manual control valve • metered control valve • service faucet • hand showers
Controlled Energy Corporation "Aquastar" Fiddler's Green, Box 19 Waitsfield, VT 05673 800/642-3111	• instantaneous water heater
Coyne & Delany Company P.O. Box 411 Charlottesville, VA 22901 804/296-0166	• flush valve
Florida Solar Energy Center 300 State Road 401 Cape Canaveral, FL 407/783-0300	• solar energy technical assistance
Leonard Valve Company 1360 Elmwood Avenue Cranston, RI 02910 401/461-1200	• engineering design service • manual control valve • metered control valve • thermostatic mixer valve • thermometer • shower head • hand showers

Lynnwood Industries
543 Lafayette Ave.
Hawthorne, NJ 07505
201/427-0500

- shower head

Mark Controls Corporation
"Powers Process Controls"
3400 Oakton Street
Skokie, IL 60076
312-673-6700

- thermostatic mixer valve
- pressure balancing valves
- hand showers

McKinney Washroom Accessories
1591 Indiana Street
San Francisco, CA 94107
415/282-7800

- stainless steel shelf
- stainless steel grab bars
- stainless steel waste container
- stainless steel clothes hook
- stainless steel soap dish
- waterproof shower seats

Monarch Tool & Mfg. Co.
105 E. 4th St.
P.O. Box 427
Covington, KY 41012
800/462-9460

- coin/token-metered shower control equipment

Paloma Industries, Inc.
1440 Howard Street
Elk Grove Village, IL 60007
708/806-1010

- instantaneous water heater

Sage Advance Corp.
"Copper Cricket"
4209 West 6th Ave., Suite A
Eugene, OR 97402
503/485-1947

- solar collector
- solar heat exchanger

Sloan Valve Company
10500 Seymour Ave..
Franklin Park, IL 60131
708/671-4300

- flush valve
- shower head

Sun Quest, Inc.
"Fresource"
1555 Rankin Ave.
Newton, NC 28658
704/465-6805

- solar collector
- solar heat exchanger

Super Secur Mfg. Company
a Division of Acorn Engineering
P.O. Box 3527
City of Industry, CA 91744
818/333-2543

- engineering design service
- prefabricated shower buildings

Symmons Industries, Inc.
31 Brook Drive
Braintree, MA 02184
617/848-2250

- engineering design service
- manual control valve
- metered control valve
- shower head
- hand showers

Tubular Specialties Mfg.
13011 S. Spring St.
Los Angeles, CA 900061

- stainless steel shelf
- stainless steel grab bars
- stainless steel waste container
- stainless steel clothes hook
- stainless steel soap dish
- waterproof shower seats

U.S. Solar Corp.
"Eagle Sun"
P.O. Drawer K
Hampton FL 32044
800/874-2190

- solar collectors
- solar heat exchanger

Watts Regulator
Rte. 114 and Chestnut Street
No. Andover, MA 01845
508/688-1811

- thermostatic mixer valve
- pressure regulator valve

Willoughby Industries, Inc.
2210 West Morris Street
Indianapolis, IN 46221
800/428-4065

- engineering design service
- metered control valve
- thermostatic mixer valve

SHOWER WALL AND FLOORING MATERIALS

Alliance America Corporation
P.O. Box 920488
Atlanta, GA 30092
404/447-5043

- porcelain enamel on steel panels

Dri-Dek Corporation
Kendall International Centre
P.O. Box 8839
Naples, FL 33941
800/348-2398

- plastic interlocking floor tile

Garon Products, Inc.
1924 Highway 35, CN 20
Wall, NJ 07719
800/631-5380

- epoxy coatings
- epoxy floor toppings

Kemlite Company
P.O. Box 2429
Joliet, IL 60434
800/435-0080

- reinforced fiberglass wall panels

L&M Construction Chemicals, Inc.
14851 Calhoun Road
Omaha, NE 68152
800/362-3331

- acrylic concrete coatings

Mateflex—Mele Corporation
1712 Erie St.
P.O. Box 6538
Utica, NY 13504-6538
800/635-6353

- plastic interlocking floor tile

Muni-Chem Corporation
P.O. Box 10207
Reno, NV 89510
800/648-1153

- acrylic conctete coatings

Omni Tech Industries, Inc.
6501 West 91st Avenue
Westminster, CO 80030
303/430-7300

- epoxy wall coatings
- quartz broadcast epoxy-resin floor toppings

Peterson Chemical Corporation
"Torginol"
710 Forest Ave.
Sheboygan Falls, WI 53085
800/558-7596

- epoxy wall and floor coatings
- quartz broadcast epoxy-resin floor toppings

Santana Products Company
P.O. Box 2021
Scranton, PA 18501
800/368-5002

- plastic partition
- plastic shelf
- plastic bench
- plastic shower

Tera-lite, Inc.
1631 South 10th St.
San Jose, CA 95112-2594
800/325-0671

- quartz broadcast epoxy-resin floor toppings

The Burns & Russell Company
"Spectra Glaze Masonry"
P.O. Box 6063
Baltimore, MD 21231
800/638-3188

- glazed masonry blocks

Thermo Materials, Inc.
P.O. Box 9454
San Diego, CA 92169
800/882-7007

- plastic tile coating for walls

RV SANITARY DUMP STATION FIXTURES

Formrite Tube Company
"Romort Water Tower"
Two Rivers, WI 54241
414/793-1171

- water towers
- information sign
- foot pedal cover

Jay R. Smith Mfg. Co.
Div. of Smith Industries, Inc.
"Humpty Dumpster"
2781 Gunther Park Drive, East
Montgomery, AL 36109
205/277-8520

- integrated RV sanitary dump station island, with plumbing package.

ELECTRICAL SERVICE EQUIPMENT

CI Power Products
4902 Tollview Drive
Rolling Meadows, IL 60008
312/398-6775

- modular pedestal enclosure (polycarbonate "Lexan")
- receptacle outlets and accessories

Dyna-tech Corporation
"Powercraft"
13020 South Belcher Road
Largo, FL 34643
813/536-1347

- pedestal enclosure (metallic)
- receptacle outlets and accessories

Midwest Electric Products, Inc.
P.O. Box 910
Mankato, MN 56002
507/625-4414

- pedestal and post enclosure (metallic and polycarbonate "Lexan")
- receptacle outlets and accessories

Milbank Manufacturing Company
P.O. Box 419028
Kansas City, MO 64141
816/483-5314

- pedestal enclosure (metallic)
- receptacle outlets and accessories

Unicorn Products Division
1511 Kraemer Blvd
Anaheim, CA 92816
714/939-9655

- pedestal and post enclosure (metallic)
- receptacle outlets and accessories.

Hialeah Meter Company
450 W. 28th ST.
P.O. Box 1047
Hialeah, FL 33011
800/654-0821

- watthour meters

OTHER SUPPLIERS

Hamilton Mfg. Corporation
3350 Secor Rd.
Toledo, OH 43606
419/535-7667

- change vending machines

Seton Name Plate Co.
P.O. Box FD-1331
New Haven, CT 06505
800/243-6624

- Adhesive/labels for identifying hazards, labeling plumbing fixtures, energy/water conservation messages, etc.

Trumbull Recreation Supply Co., Inc.
Route 32 (Hall Complex)
South Willington, CT 06265
800/243-0134

- campground equipment and supplies
- coin/token-metered shower control equipment

APPENDIX II
Design Plans

The following sources can be contacted for available plans and drawings of recently built facilities.

SHOWERS

Region 3—Tonto National Forest, Arizona
(Solar-heated water system)

Region 5—San Bernardino National Forest, California
("Unisex" building design)

Region 6—Umpqua National Forest, Oregon;
Siuslaw National Forest, Oregon Dunes NRA, Oregon
("Traditional" building design)

Region 8—Regional Office
(Region-wide standard design)

RV SANITARY DUMP STATIONS

Forest Service-wide—Regional Offices
(contact: Facilities Engineer or Architect)

RV ELECTRICAL SERVICE HOOKUPS

Region 8—William B. Bankhead National Forest, Alabama

APPENDIX III

Reference Sources

California State Accessibility Standard—Interpretive Manual, 1989, Office fo the State Architect Access Compliance Unit.

Design Guide for Accessible Outdoor Recreation (Interim Draft), 1990, Interagency Task Group for Outdoor Recreation.

Engineers Digest, "Floor Repairs: Let your business be your guide," October 1989.

Feasibility Analysis—Public Showers, 1986, Thomas Spencer.

National Electrical Code, 1990, National Fire Prevention Association.

Park Maintenance Standards, 1986, National Recreation and Parks Association.

Public Works—city, county, State, 1989, Vol 120 No 5, Public Works Journal Corp.

Recreational Vehicle Disposal Station at Highway Rest Areas, 1983, Washinton State Department of Transportation.

Solar Water Heating—a consumer guide, Florida Solar Energy Industries Assn.

Water-Efficient Technologies for the Urban/Residential Sector, 1988, Rocky Mountain Institute.

Uniform Federal Accessibility Standards, 1985, Architectural and Transportation Barriers Compliance Board.

For additional information contact:

Recreation Program Leader
San Dimas Technology & Development Center
444 E. Bonita Ave.
San Dimas, CA 91773

Phone: 714/599-1267
FTS: 793-8000
Fax: 714/592-2309
DG: W07A

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