TECHNICAL SUPPORT PACKAGE

This report contains the names and addresses of organizations from which NASA purchased services, materials, systems, etc., in connection with the advanced technology items used in the Technology Utilization House. The listing of these organizations is not to be construed as an endorsement or recommendation by NASA, but only as one available source. Where prices are included, they are those in effect prior to June 1976 and are provided only as general information.

NASA

TECHNOLOGY UTILIZATION HOUSE

TECHNICAL SUPPORT PACKAGE

Table of Contents

INTRODUCTION & SUMMARY

As a homeowner you soon may be the beneficiary of significant new technology, much of it coming from the Nation's space program. New building materials, better use of existing energy as well as new uses of solar energy, water conservation, fire-prevention techniques, and a variety of household products are outgrowths of our national investment in the aerospace program.

Builders and manufacturers of homes and housing equipment need new methods and materials to survive in a highly competitive market. Probably the most significant opportunity for change in houses over the next few decades will be in energy management. Our homes consume about 20 percent of the energy used in the United States each year - an amount almost equal to all imported crude oil.

The NASA Technology Utilization House, called Tech House, was designed and constructed at NASA's Langley Research Center in Hampton, Virginia, to demonstrate new technology that is available or will be available in the next several years and how the application of aerospace technology could help advance the homebuilding industry. Solar energy use, energy and water conservation, safety, security, and cost were major considerations in adapting the aerospace technology to the construction of Tech House.

A committee, comprised of representatives from the Department of Housing and Urban Development, the National Association of Home Builders Research Institute, the Bureau of Standards, the Consumer Product Safety Commission, and NASA personnel, was formed for the purpose of identifying new technology and guiding the design of Tech House. In addition to this committee, NASA utilized the services of an architectural engineering firm to perform system studies, evaluate proposed construction methods, perform cost effectiveness studies, and prepare final drawings incorporating the technological outgrowths into Tech House construction.

Tech House is a single level structure of contemporary design, comprised of two square modules connected by a flat-roofed hallway containing an entry vestibule at the front and rear and a laundry room in the rear vestibule. The connecting hallway uses a skylight which reduces the need for artificial light during daytime and may be opened for ventilation.

While Tech House is not large, it is extremely functional and contains approximately 1500 square feet of enclosed living space consisting of three bedrooms, living room with fireplace, dining area, kitchen, two bathrooms, and laundry room, plus an attached garage. It is expected that within 5 years the house, with all its special features, could be built commercially for approximately $45,000 (in 1976 dollars) on an existing lot. However, this forecast is based on the mass production of components and is subject to the homeowner's personal preferences and location.

One of the first steps in Tech House planning was to determine energy consumption requirements and how total energy could be reduced. This was accomplished by analyzing different types of ceilings, roofs, windows, doors, and insulations to determine which would be most energy efficient and cost effective. A system or product was considered "cost effective" if its added initial cost plus 10 percent interest could be returned to the buyer through energy or other savings over the lifetime of that system. The results of these studies, showing a comparison of energy consumption in a contemporary house, electrically heated and constructed by 1974 standards, with energy consumption projected for Tech House, follow:

Energy Consumption		Contemporary House (KW-HR)	Tech House (KW-HR)
Central heating		29,300	6,000
Central air conditioning		3,600	2,100
Water heating		4,380	1,500
Lights		2,000	1,000
Appliances		5,609	3,400
Miscellaneous		1,111	1,000
	Total	46,000	15,000 (Approx. 66% reduction)

A study which had previously been conducted by NASA determined that a significant reduction in domestic water consumption could be achieved by recycling waste water for toilet flush and using recently developed water saving fixtures, such as water saver shower heads and low profile water closets. The following comparative figures were based on that study:

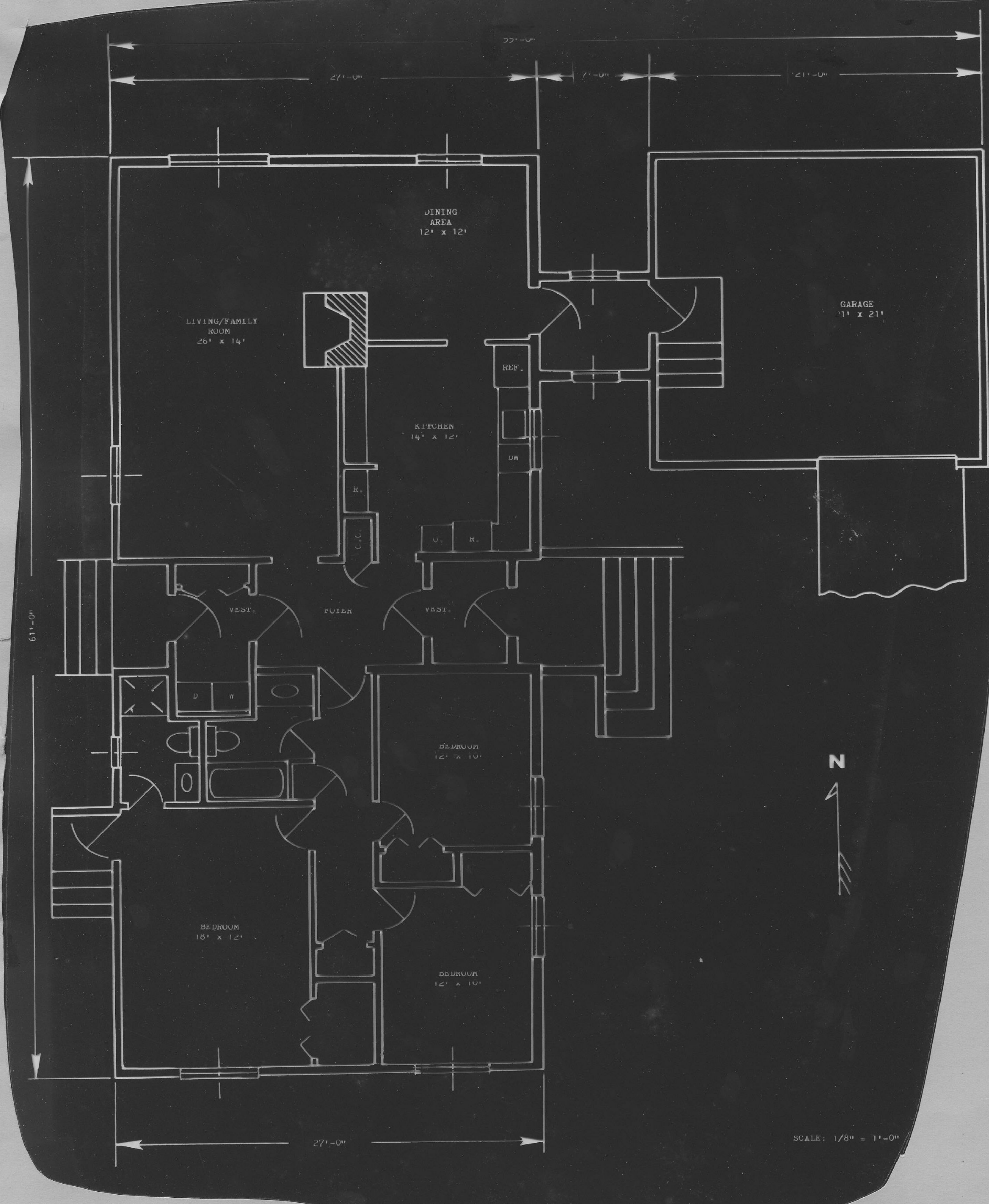
Water Consumption (For a Family of Four; Excluding Lawn Watering)		Contemporary House (Gals.)	Tech House (Gallons)
Bathing		22,265	16,480
Dishwashing		2,920	2,190
Laundry		5,840	5,840
Cleaning		2,190	2,190
Toilet		32,485	0
Miscellaneous		7,300	7,300
	Total	73,000	34,000 (Approx. 50% reduction)

While the reduction in energy and water consumption represents considerable savings in utility costs, it is important to note that additional savings can result from fire-resistant construction and solar energy usage. The use of fire-resistant carpets, drapes, furniture covers, insulation, and other materials can result in lower fire insurance rates, and many states encourage the use of solar energy by providing tax break incentives for homeowners.

In addition to conservation of energy and water, the safety and security of the homeowner's family were also considered in choosing products to be installed in Tech House. Therefore, advanced security detectors for protection against fire, smoke, tornadoes, and intruders were incorporated in its construction.

It should be pointed out that energy-conserving homes are most efficient when carefully designed to fit specific sites with their particular characteristics of access, orientation to sun and winds, history of weather conditions, and thermal requirements. For this reason, Tech House was not intended to be, and should not be, considered a prototype or mass-producible design suitable for all locations. Instead, Tech House should be viewed as a demonstration model and research facility containing many individual systems, components, products, and ideas which can be applied in some degree to all housing.

Detailed descriptions of special systems and features incorporated in Tech House follow.



Tech House Floor Plan

SOLAR ENERGY USE
AND
ENERGY CONSERVATION TECHNIQUES

HEATING

The heating system for Tech House utilizes solar energy to supply the major heating requirements through one of several modes of operation depending on heat requirements, weather conditions, and water temperatures in the storage tank. The major components in the heating system, shown in the schematic diagram (page 9), are the solar collectors where water passes through flat plates, thermal storage tank, heat pumps, and direct heat exchanger.

Solar energy is collected by 384 square feet of black flat-plate solar collectors mounted at an angle of 58 degrees on the south facing roof of Tech House. The solar collectors heat the water for heating the house or for raising the temperature of the water in a thermal storage tank, which is insulated and buried in the ground. The thermal storage tank has a 1900-gallon capacity and is used to store energy for use at night and on overcast days. The storage tank was designed to store enough energy to provide sufficient heat for up to 5 consecutive days. When direct solar heating is not available, a heat pump is used to transfer stored heat from the storage tank to the house. On clear days, if heat is needed in the house, hot water from the solar collectors is circulated directly through the direct heat exchanger where heat is transferred from the water to the air.

If heat is not required in the house, the hot water from the solar collectors is diverted to the thermal storage tank to increase the temperature of the stored water. At night and on overcast days when solar energy is not collected, heat is supplied to the house by circulating hot water from the storage tank through the direct heat exchanger. When the temperature of the stored water drops below 110°F, the heat pumps transfer heat from the storage tank to the house. If the stored water temperature drops below 55°F, two wells (shown on the schematic, page 9) provide an additional source of water from which the heat pumps can transfer heat to the house. However, the stored water temperature is not likely to fall to the 55°F level unless there are 10 to 15 continuous overcast days with extremely low temperatures.

As discussed in a subsequent section on the fireplace, water can also be heated by circulation through the fireplace grate/coil. The heated water is then circulated through the direct heat exchanger or to the storage tank.

A review of the schematic shows that numerous solenoid valves and several pumps are utilized in the heating system. These valves and pumps are operated by differential temperature flow controllers, which provide electrical signals when preset temperature differentials exist within the system.

The ductwork which distributes the warm air throughout the house is part of a zone control system using advanced controls to accurately and automatically control the temperatures in the three areas of living, sleeping, and bathing. This system for control of heating and cooling will result in substantial energy savings. A computer monitors inside temperatures and, by means of a computer program written to reflect the family's activities, heats only the rooms being used. This computer can be made not much larger than a pocket calculator. During winter days, the module containing the living areas will be warm, while the module with the bedrooms will be cool. At bedtime, the program will be reversed, with warm bedrooms and bathrooms and cool living areas. A manual override will return control of the system to the occupant during an emergency. For research purposes of NASA, the equipment shown on page 12 was installed in the garage to record the effectiveness of the different systems and their components. This would normally not be in a home.

The heating system in Tech House is more complicated than would be necessary for the normal home because of the experimental features incorporated for evaluation purposes. The four possible modes of heating could be reduced to supplying solar energy to the storage tank in a closed system and then utilizing a second closed system, including the heat pump, to transfer heat to the house. The backup would be electrical heaters installed in the heat pump. A schematic diagram for such a simplified system is shown on page 10.

Additional energy-conserving features incorporated into Tech House include the entry vestibules and the south window areas with roof overhang.

The entry vestibules at the front and rear of the Tech House hallway act as air locks and prevent the loss of large quantities of heated or cooled air from inside the house while the outside door is open. The reduction in heated or cooled air loss becomes significant during extremely cold winter days or hot summer days.

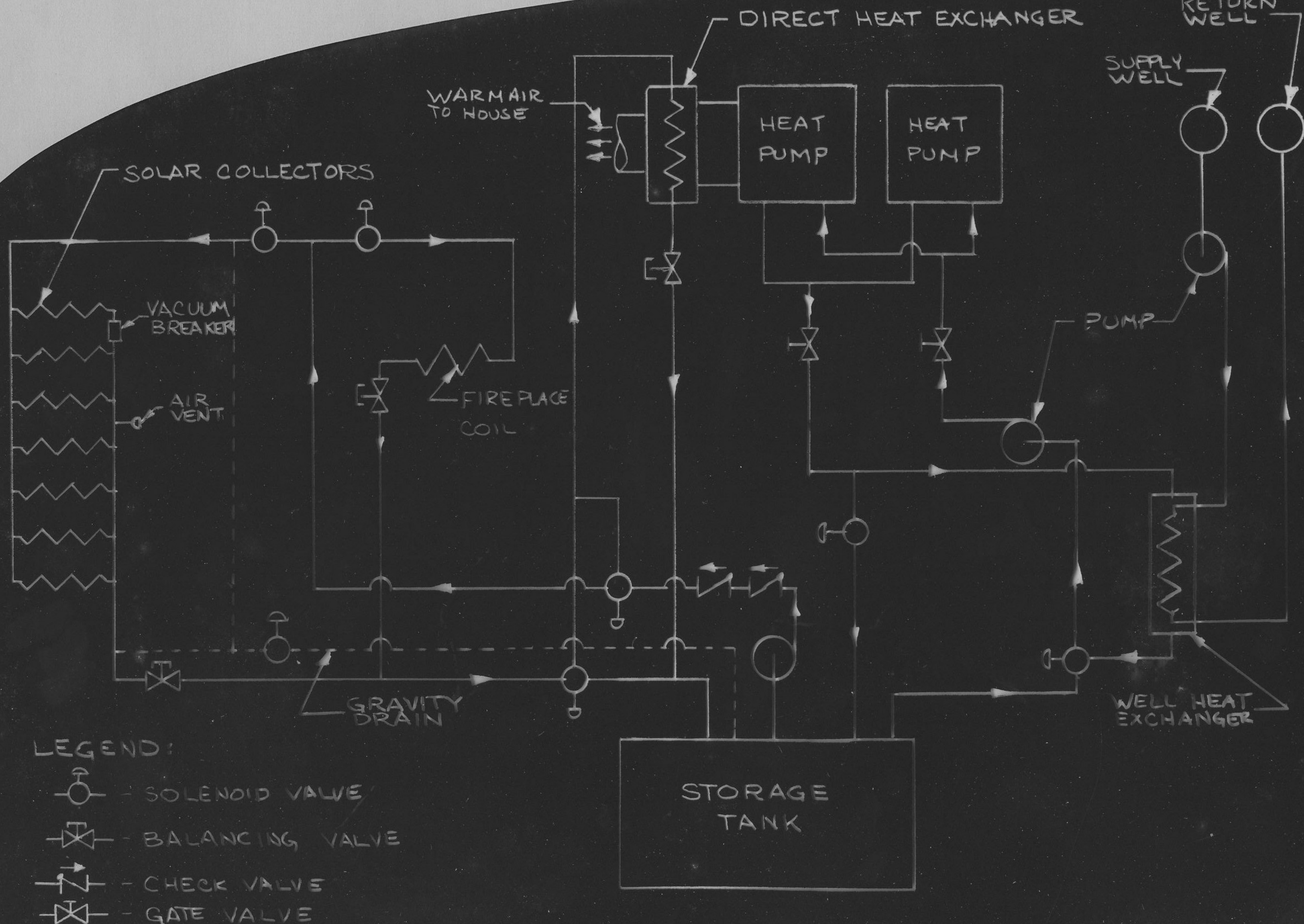
The large window area on the south wall, the overhanging roof, and the exterior retractable shutters result in significant energy savings. The large glass area allows solar energy to be transmitted into the house through the windows during the winter days. At night, the shutters keep the heat from escaping from the house. The roof overhang was designed to allow the sun to shine through the south windows in the winter when heat is needed, but to shade the windows from the summer sun when it is desirable to keep the heat gain low.

The water source heat pumps used in the Tech House were purchased from:

Florida Heat Pump Corporation
610 Southwest 12th Avenue
Pompano Beach, Florida 33060
Telephone: (305) 781-0830

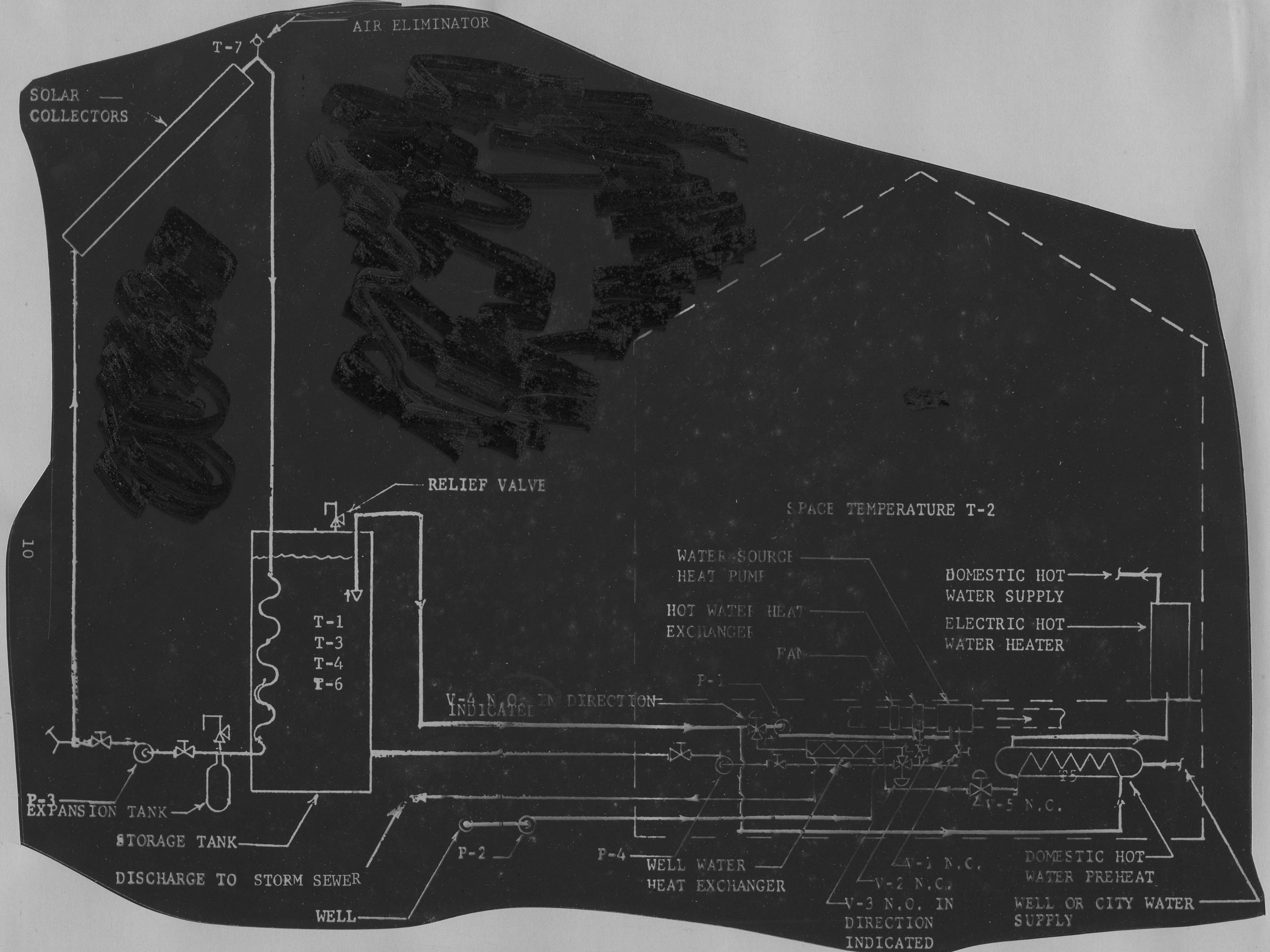
The solar collectors used in the Tech House were purchased from:

Chamberlain Manufacturing Corporation
845 Larch Avenue
Elmhurst, Illinois 60126
Telephone: (312) 279-3600



TECH HOUSE HEATING SYSTEM SCHEMATIC

BY______ DATE______
CHKD. BY______ DATE______
SUBJECT______
SHEET NO.______ OF______
JOB NO.______



Simplified Solar Heating Schematic

Solar Collectors

*Systems Monitoring Equipment

*For NASA research purposes only.
Would not normally be in home.

COOLING

The cooling system for Tech House utilizes the same equipment and components as the heating system, except that the night radiators on the garage roof replace the solar collectors. These night radiators face north and as the hot water from the storage circulates through them, heat radiates to the atmosphere, thereby lowering the temperature of the stored water.

To cool the house, the heat pump is used to transfer heat from the house into the storage tank where it raises the temperature of the water. Thus, cooling is provided by raising the water temperature during the day and lowering it at night by using the night radiators. When the temperature of the water in the storage tank reaches 90°F, the system automatically switches to the wells as a source of 55°F water to which the heat from the house can be transferred. The system is shown in the schematic on page 14, simplified to show only the components used for cooling. In reality, most of the equipment is used for both heating and cooling, and the piping for both systems is interconnected. The valves and pumps in the cooling system are controlled in the same way as in the heating system, including the zone temperature control system.

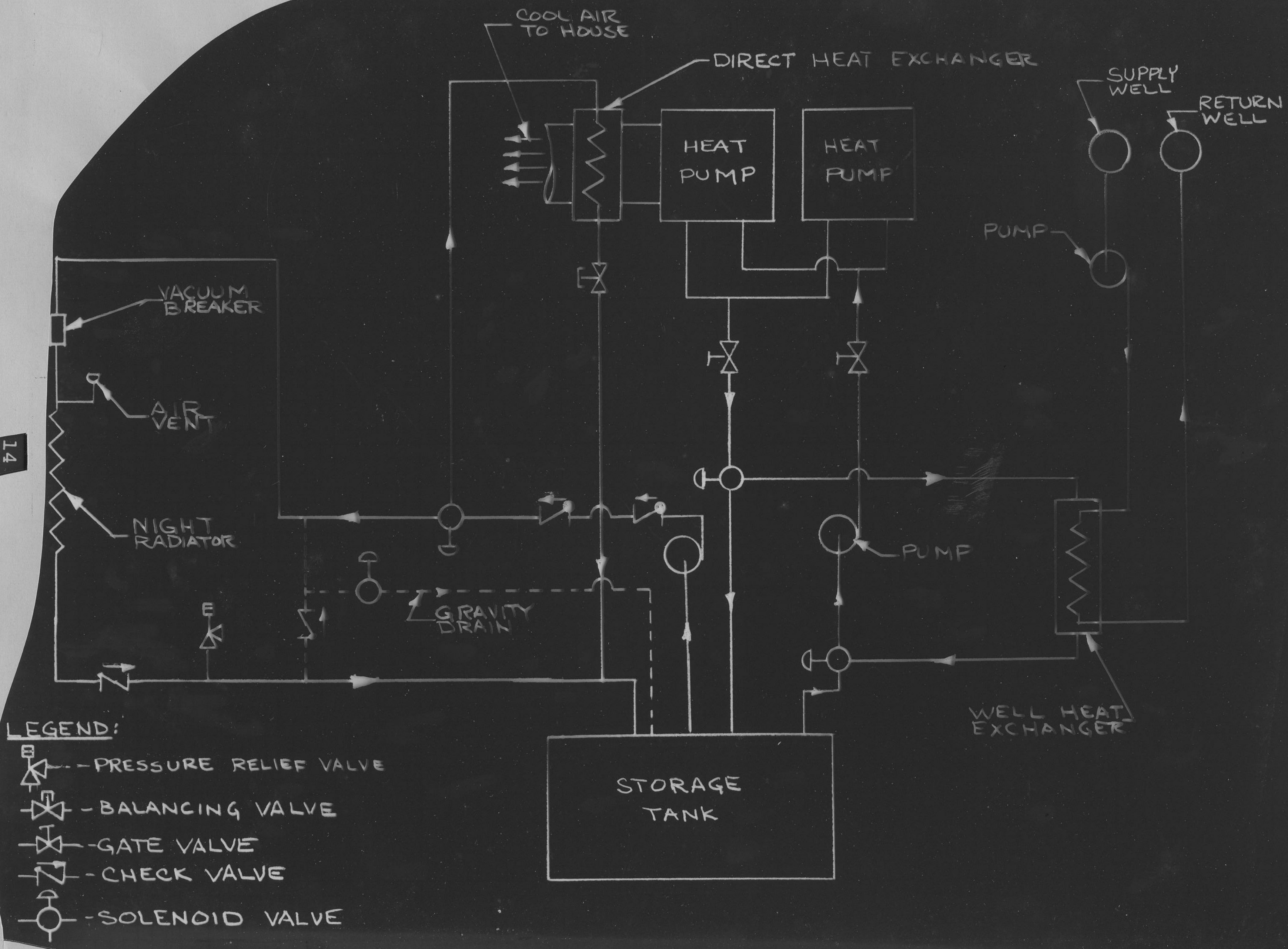
In many homes, a significant part of the cooling load results from the hot attic air which may reach temperatures up to 160°F during hot summer days. The use of power ventilators may reduce the attic air temperature to 90 - 110°F. However, Tech House has incorporated large ventilation louvers in the attic space, which keep the attic air temperature within a few degrees of the outside air temperature. The use of these louvers has reduced the cooling load while requiring no energy consumption to operate a fan.

Water-to-air heat pumps are available from several manufacturers. The supplier for the Tech House was:

Florida Heat Pump Corporation
610 Southwest 12th Avenue
Pompano Beach, Florida 33060
Telephone: (305) 781-0830

The supplier of the night radiators was:

Olin Brass Corporation
East Alton, Illinois 62024
Telephone: (618) 258-2000



TECH HOUSE COOLING SYSTEM SCHEMATIC

14

3 back

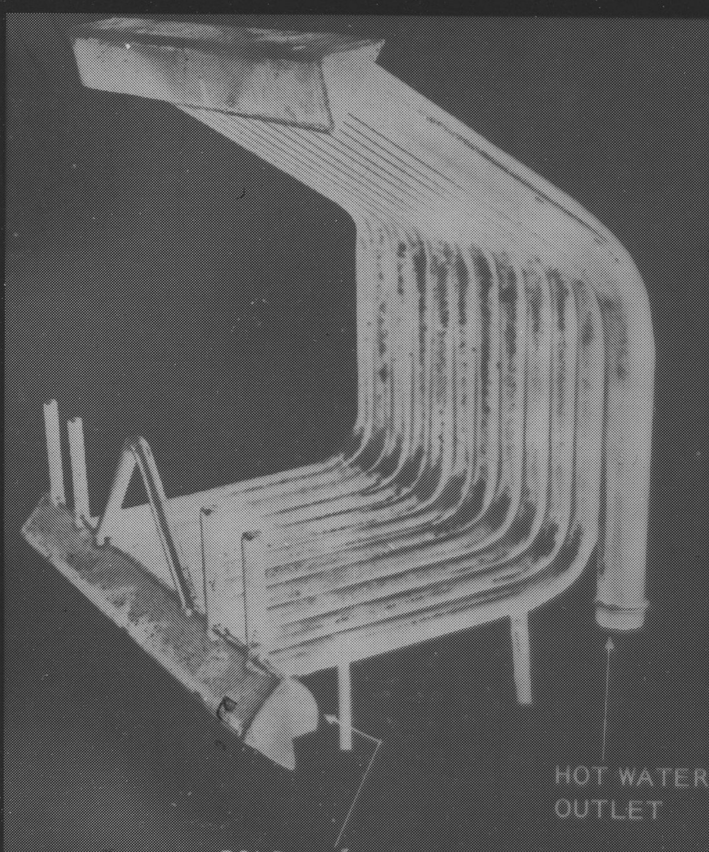
BY ____ DATE ____
CHKD. BY ____ DATE ____
SUBJECT ____
SHEET NO. ____ OF ____
JOB NO. ____

FIREPLACE

The fireplace, as utilized in Tech House, is an integral part of the heating system. Fresh combustion air from outside, rather than using already heated air from inside the room as conventional fireplaces do, is supplied by a duct directly to the firebox, thereby significantly reducing heat loss up the chimney. Room-heating capacity is further increased by the use of a double-wall metal firebox which allows some escaping energy to be returned to the room. Additionally, the temperature of the water in the storage tank can be increased by circulating it through the fireplace grate, which is a coil through which water can flow. These special features increase the efficiency of the fireplace from the usual 10 percent to 50 percent.

The water circulating grate/coil used in the fireplace was fabricated at the Langley Research Center. It is expected to recover 30,000 BTU's per hour from an available 95,000-BTU log fire. Water grate systems using similar concepts are available commercially, can be installed in existing fireplaces, and are adaptable to hot water, forced air, or electrically heated homes. One manufacturer claims a 40-percent recovery of heat generated by the fireplace fire.

Manufacturer of Hydrohearth: Ridgway Steel Fabricators, Inc.
Box 382
Ridgway, Pennsylvania 15853
Telephone: (814) 776-1323 or 776-6156



Hydrohearth by Ridgway Steel Fabricators

EXTERIOR RETRACTABLE SHUTTERS

The exterior retractable shutters* used on Tech House windows provide energy savings by holding heat in during the winter and keeping heat out during the summer. The shutters can be raised or lowered in seconds from inside the house by either an electric motor or a hand-operated crank. Additional benefits achieved through installation of exterior retractable shutters are:

-- Noise Reduction. The shutters provide an additional barrier to noise transmission.

-- Security Protection. When lowered, the shutters self-lock and cannot be raised from outside the house.

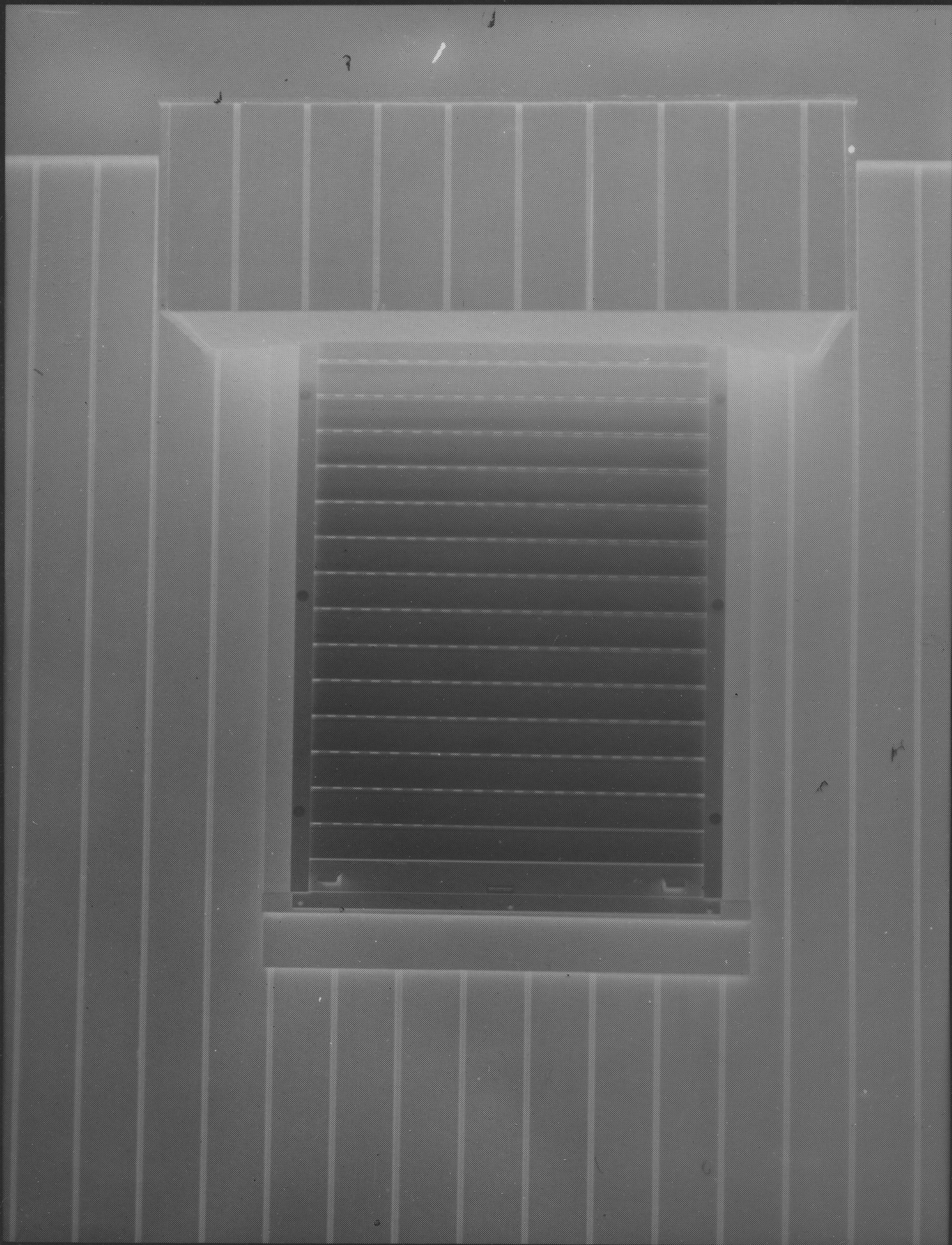
-- Light Control. The shutters can be adjusted to expose vents between the slats to admit soft light, or they can be closed completely to shut out all light. Exposure of the vents will also permit air to flow through the shutters.

-- Storm Protection. Closed shutters are a deterrent to flying debris.

Manufacturer: Pease Company
2001 Troy Avenue
New Castle, Indiana 47362
Telephone. (317) 529-1700

---

*The exterior retractable shutters are an example of cost-effective technology used in Tech House which was not directly related to the aerospace program.



Exterior Shutter with Vents Exposed - Shutter Not Completely Closed

INSULATION

Urea tripolymer foam, a nonpetroleum-based product, was used in the ceiling, selected interior walls, and all exterior walls of Tech House. This material has the ability to flow into a variety of spaces, around wires, piping, and other obstructions. Tripolymer is a nonexpanding, cold-setting foam which will not settle. It is a good insulating material which is also nonflammable, nontoxic, odor free, rodent resistant, and presents an effective barrier to noise transmission. Tripolymer will self-insulate against fire by forming a charred crust when exposed to flame or intense heat. It is completely self-extinguishing with no flame advance beyond the source of ignition.

The exterior walls were constructed using 2- by 6-inch studs on 24-inch centers instead of the usual 2- by 4-inch studs on 16-inch centers so that 5½ inches of tripolymer insulation could be installed in the exterior walls. The insulating qualities of tripolymer foam are indicated by the thermal resistance or R value. The R value for the 5½ inches of tripolymer in the exterior walls is 24.64 and for the 6 inches in the ceiling is 26.88 as compared to fiberglass of 19 and 22, respectively.

Tripolymer is also an ideal material for the insulation of any cavity in existing structures, since it can be applied through an opening as small as 1½ inches in diameter.

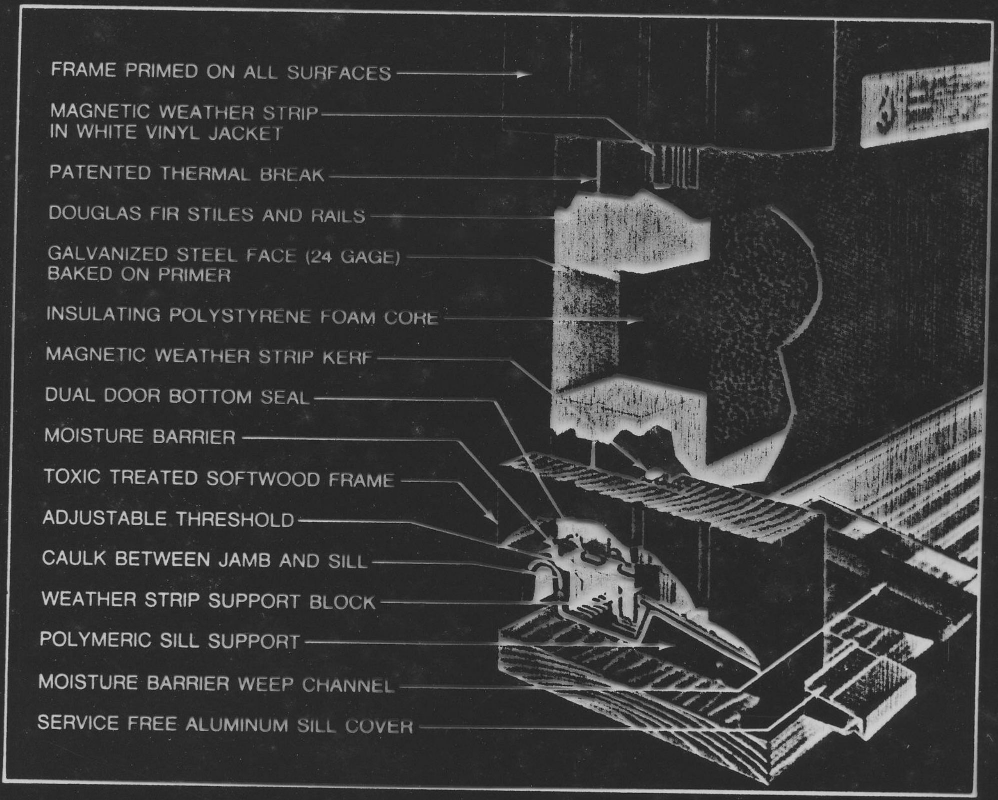
Manufacturer: C. P. Chemical Company, Inc.
25 Home Street
White Plains, New York 10606
Telephone: (914) 428-2517

EXTERIOR DOORS

The exterior doors on Tech House have steel surfaces with polystyrene foam cores and magnetic weather-stripping.

The steel surfaces are hot-dipped galvanized for rust and corrosion resistance. The expanded polystyrene foam core provides superior insulation and maintains a separation of the metal panels so that heat and cold cannot be transferred from one side to the other. An adjustable sill provides a positive seal against the weatherstrip in the bottom of the closed door. Each of these metal doors used will save approximately $39 a year in energy costs.

Manufacturer: Pease Company
900 Laurel Avenue
Hamilton, Ohio 45023
Telephone: (513) 867-3333



Pease Ever-Strait Door

ENERGY SAVING APPLIANCES

A study was made by the Architect-Engineer (A/E) design team to determine which appliances were most energy efficient and cost effective for use in Tech House. From this study, it was determined that various manufacturers generally had one unit which was energy efficient, while the other units were not as energy efficient as those of other manufacturers. Based on the study, the A/E design team recommended appliances from several manufacturers. The final selection was based on overall cost effectiveness of the complete set of appliances as purchased from one manufacturer.

The use of a microwave oven is especially recommended as an energy-saving appliance, because foods cooked in a microwave oven require less time for cooking, thereby using less electricity. Also, the use of a microwave oven adds little or no heat to its surroundings while cooking.

Additionally, a Super Skewer is used to help reduce energy consumption by speeding up cooking of such items as roasts. This item is a heat pipe which utilizes the capillary action of a liquid in a sealed pipe to transfer heat. The Super Skewer is inserted into the roast and transfers heat from the air in the oven to the inside of the roast, allowing it to cook from both the inside and outside.

The Super Skewer in the Tech House was purchased from:

Isothermics, Inc.
P.O. Box 86
Augusta, NJ 07822
Telephone: (201) 383-3500

The 1976 price was $10 per skewer.

WATER REUSE SYSTEM

WATER REUSE SYSTEM

An experimental program was conducted at Langley Research Center some time ago to determine if spacecraft systems could be modified to process household waste water. A typical household for a family of four was set up with appliances and fixtures to produce waste water. Instead of releasing bath and laundry water into sewer lines, the water was filtered and chlorinated for reuse as toilet flush water. The experiment revealed that this single step could easily reduce water consumption by 60 to 100 gallons a day. Another experiment processed all household water, except for toilet and garbage disposal, for multiple reuse. Units developed for spacecraft were used to determine how well domestic water could be cleaned and the energy and expendables required. It was found that overall household water consumption could be reduced by about 70 percent or by 180 gallons a day.

The water reuse system used in Tech House reduces water consumption by half when combined with other water saving methods. Water from bathroom sinks, bathtub, shower, and laundry equipment is collected in a holding tank, chlorinated, filtered, and recycled, as shown in the schematic diagram on page 25, for use as water for toilet flushing. Even though the toilet flush water is safe enough for possible tasting by children or pets, to alleviate health and safety concerns of the average homeowner, the drinking water system is entirely separate from the recycled water system.

All waste from toilets goes directly to the sewer, as does any overflow from the collection tank. One additional benefit resulting from reusing the wash water is that a trace amount of detergent remains in the recycled water and tends to keep the toilet bowls clean.

The overall reduction in requirements for water in and waste outflow also reduces requirements for community sewage systems, treatment plants, and water supply systems.

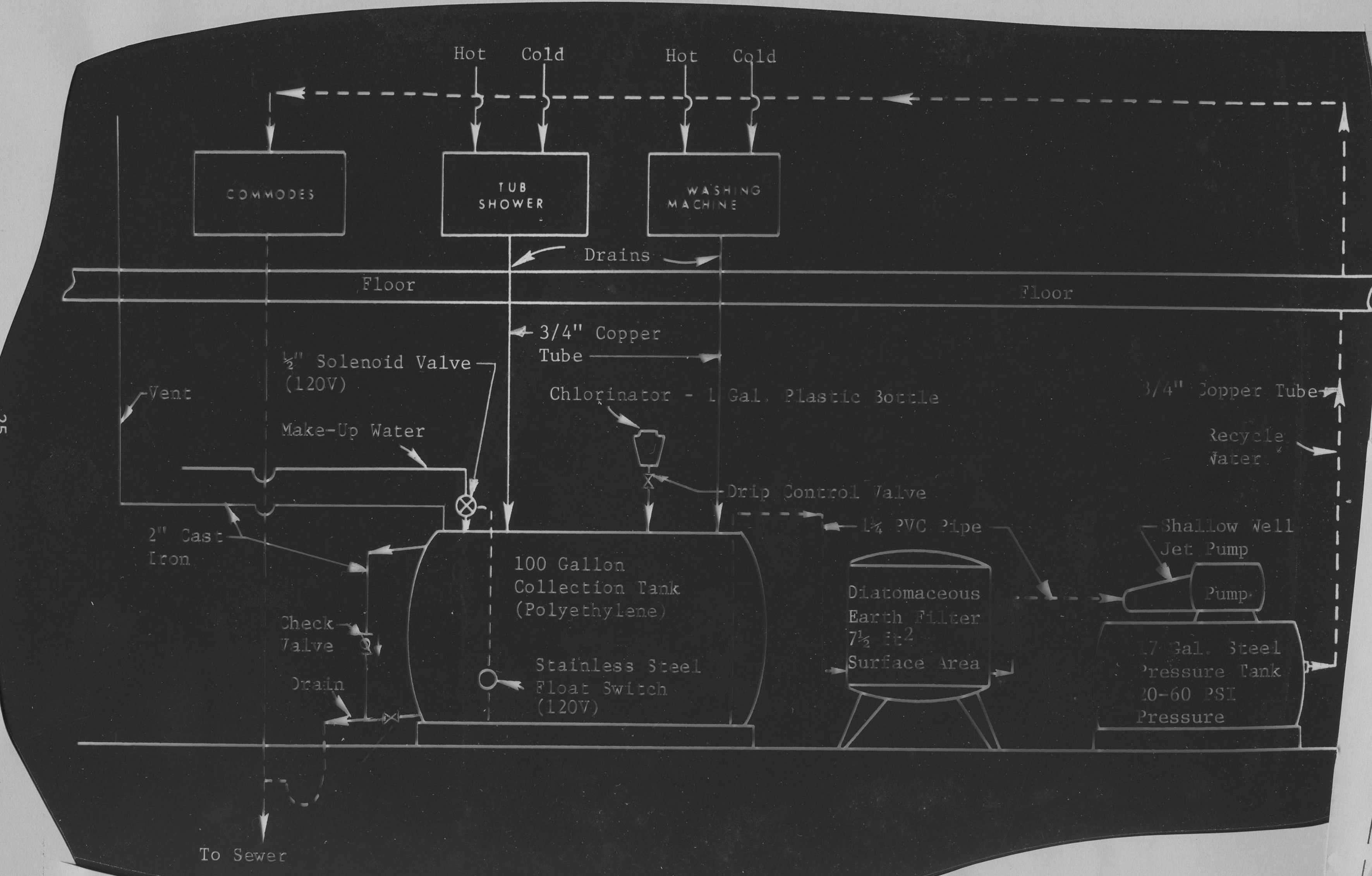
The completed experimental programs have proven that the advantages of this system outweigh any disadvantages, such as initial cost, space requirements, and cost of maintenance.

Material for the water reuse system is commercially available and was purchased at a cost of $450.

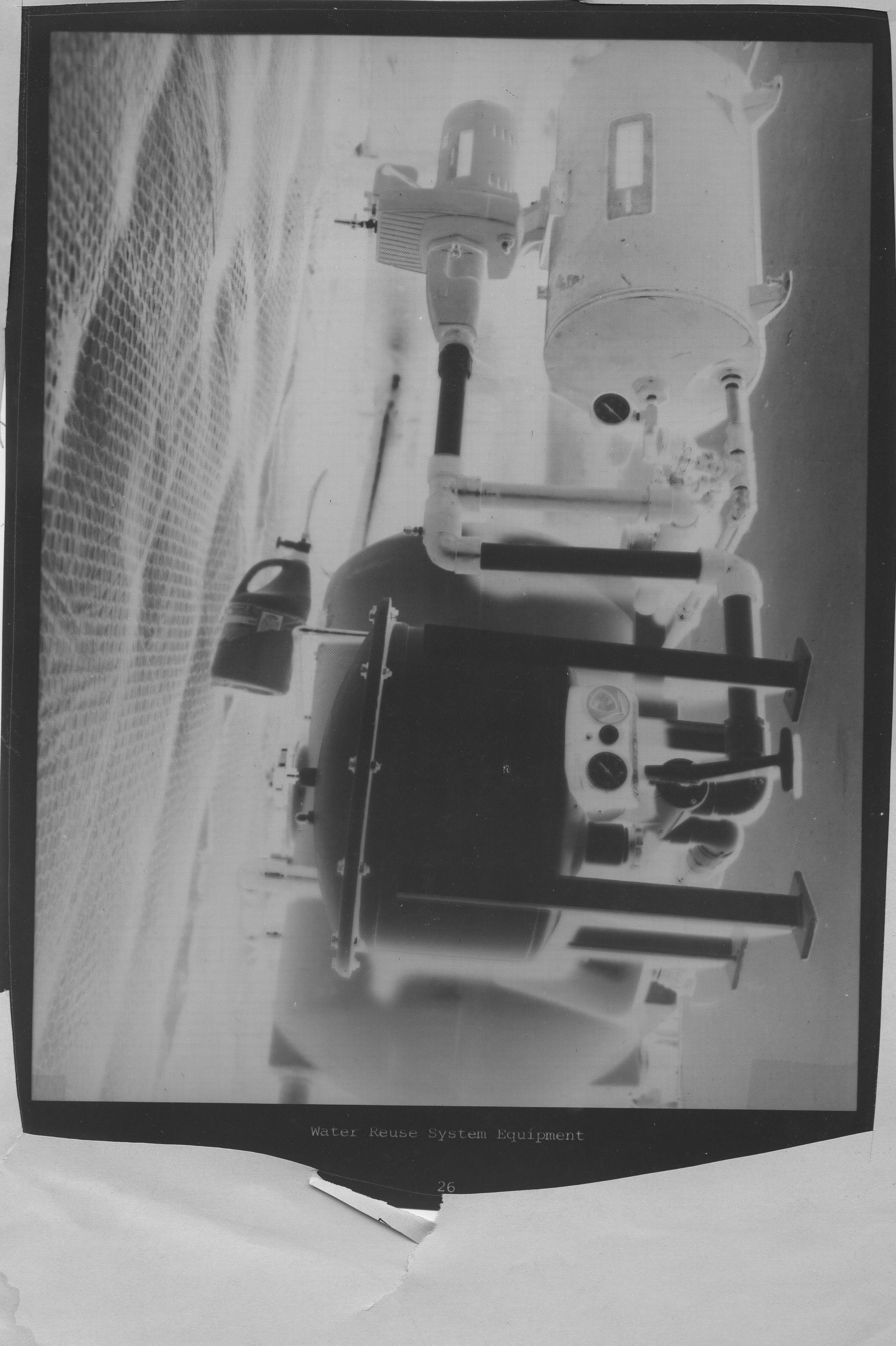
A commercially available unit is being marketed for the same use as the Tech House water reuse system. Personnel at this Center have not seen or operated the unit, but our understanding is that the design is similar to the Tech House system, except that iodine crystals are used instead of chlorine for a biocide. We are not hereby endorsing the product, but do want to make people aware of its apparent availability. Details of the system can be obtained from:

The Water-Cyk Corporation
Attn: Mr. Ed Toms
512 Maple Avenue, West
Vienna, Virginia 22180
Telephone: (703) 938-9070

A copy of the report pertaining to the experimental water reuse program conducted by this Center may be obtained from the North Carolina Science and Technology Research Center whose address appears on page 53. The report may be obtained at cost. Ask for NASA TN D-7937, "Processing of Combined Domestic Bath and Laundry Waste Waters for Reuse as Commode Flushing Water."



Water Reuse System Schematic

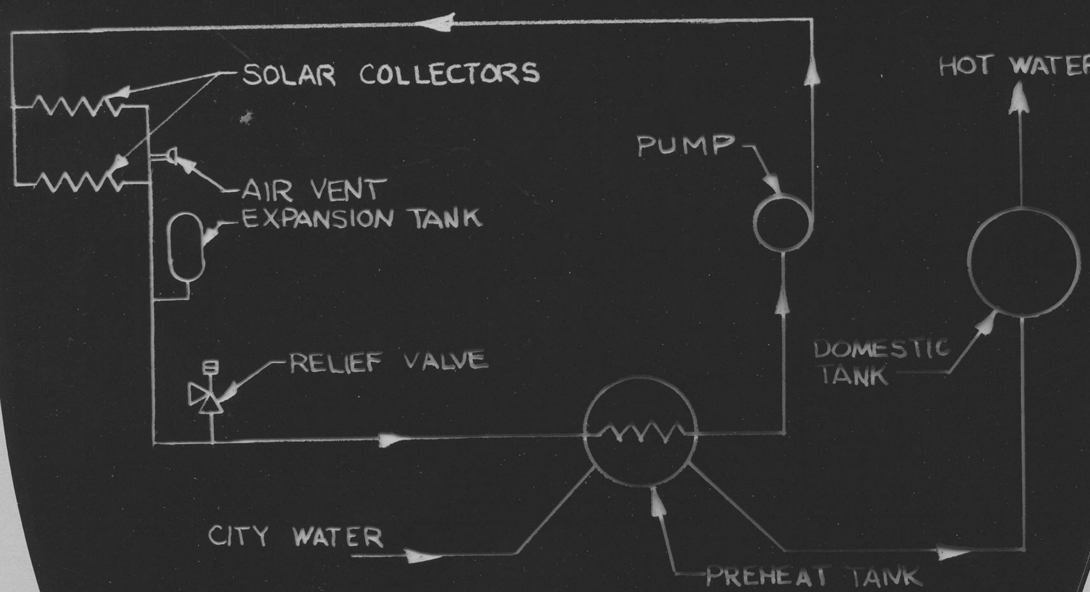


Water Reuse System Equipment

DOMESTIC HOT WATER SYSTEM

DOMESTIC HOT WATER SYSTEM

Tech House has two domestic hot water tanks located in the house-to-garage passageway. One tank contains a heat exchanger that uses solar energy to preheat incoming water to approximately 140°F. This is a closed-loop system, shown below, with 48 square feet of solar collectors, a heat exchanger, and a pump to move the water around the loop. The heated water then goes to the electric hot water heater, then to the user. If large amounts of hot water are used and the water temperature drops below the thermostat setting on the hot water tank, the water temperature is raised by electrical resistance heating to the desired temperature. Hot water heaters are available, for use in solar systems, which contain both the heat exchanger and the electric resistance heaters, thus eliminating the need for two tanks.



Domestic Hot Water System

SECURITY SYSTEMS

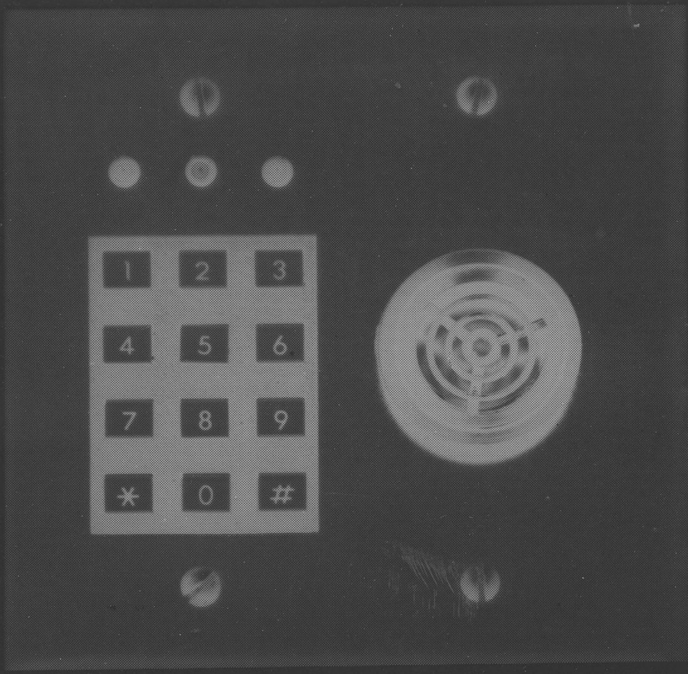
INTERIOR SECURITY SYSTEM

This system includes detectors at windows, doors, and under carpets as well as the personal security system, "Scan." The system is operated by household power, or can be adapted for operation by a 12-volt battery.

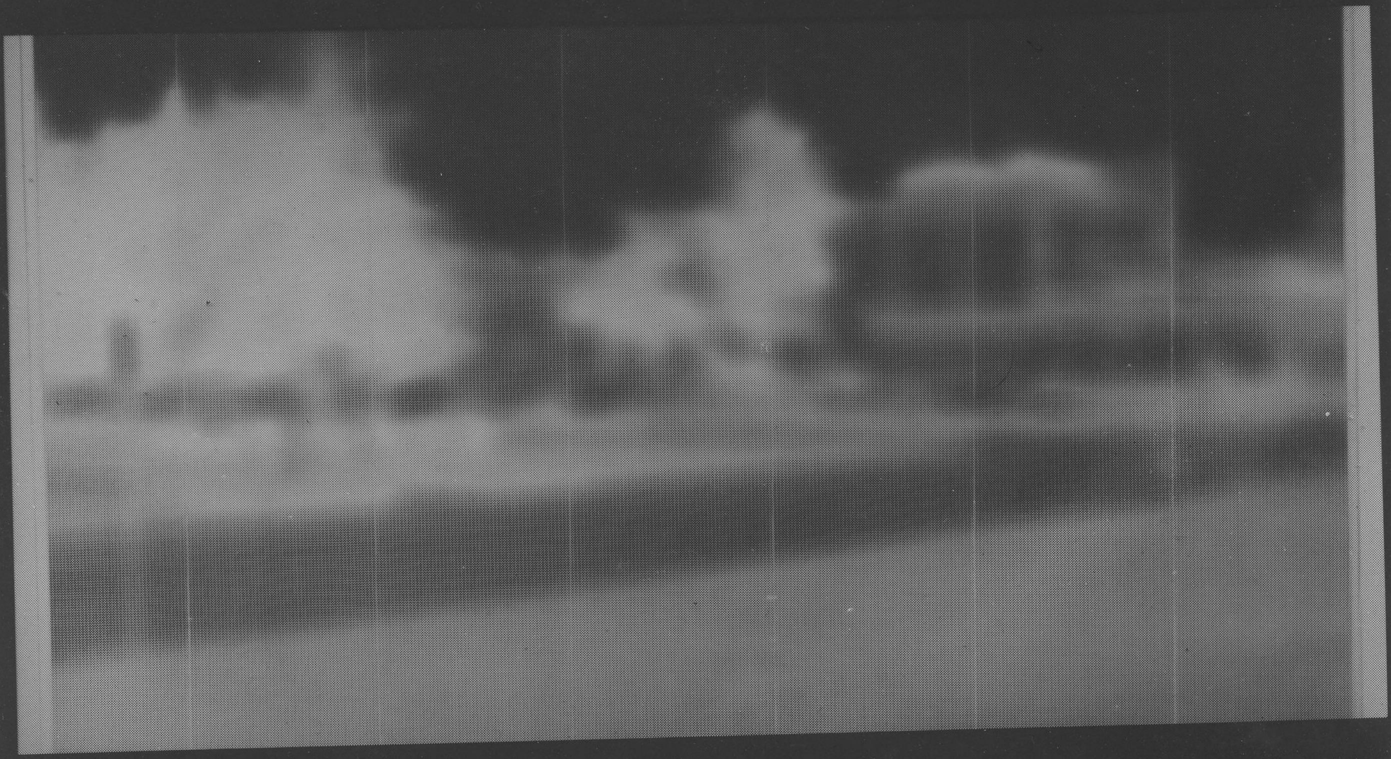
The detectors at the windows are wires woven in the screens, which must be cut or removed to gain access through the window. The alarm is activated when the wires are cut or the window screen removed. The detectors under the carpets are pressure-sensitive pads which set off the same alarm. The detector pads at the three outside doors have a built-in delay which gives the occupant time to secure the system before the alarm sounds after entering the house. When the occupant enters the code number on one of the digital panel devices, any attempt to break into the house will set off the alarm.

Muggings and burglaries often occur when a homeowner is occupied in opening the house door in the dark, from an assailant that was hiding in the brush. To light dark areas at night before entering the house, the "Scan" pocket transmitter, the size of a fountain pen, can transmit an ultrasonic signal which will turn the porch light on from a distance of about 30 feet.

Manufacturer of "Scan" and Interior Security System:	Sentry Products, Inc. Attn: Bob Hussman 245 Stockton Avenue San Jose, California 95126 Telephone: (408) 286-3515
Window Screens Wired by:	Maxwell Alarm Screens 2820 N.E. Fourth Avenue Pompano Beach, Florida 33064 Telephone: (305) 782-7710
System Installed by:	Southern Burglar Alarm Company 2400 Granby Street Norfolk, Virginia 23517 Telephone: (804) 622-1378



Interior Security System Control Panel



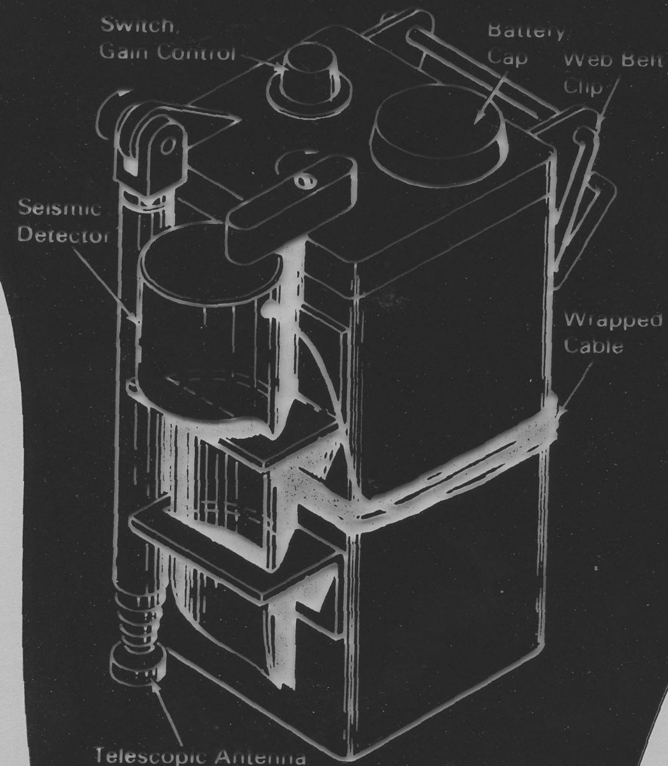
Security Wired Screens

Pressure-Sensitive Pads

EXTERIOR SECURITY SYSTEM

The exterior security system uses a seismic detector, similar to those used on the moon, to determine density and thickness. The seismic detector is planted in the ground and connected by cable to an electronic package enclosed in a water-tight container. The range of the seismic sensor is 80 meters (262 feet), and the movement of an intruder within that range causes a coil to vibrate. The amplitude and duration of the vibration depends on the intensity of the footstep impulse. The vibration of the moving coil sensor generates a voltage impulse which is amplified and transmitted to a remote FM receiver. The receiver emits a single tone burst for each footstep of a slow-walking intruder, while a running intruder will cause a continuous tone, with periodic variations indicating each footstep.

This system was fabricated at NASA's Ames Research Center and is expected to be available commercially in the near future. Information about this detector system may be obtained by requesting NASA Tech Brief 70-10638 and the Technical Support Package from the Technology Utilization Office, NASA Ames Research Center, Code AU:230-2, Moffett Field, California 94035.



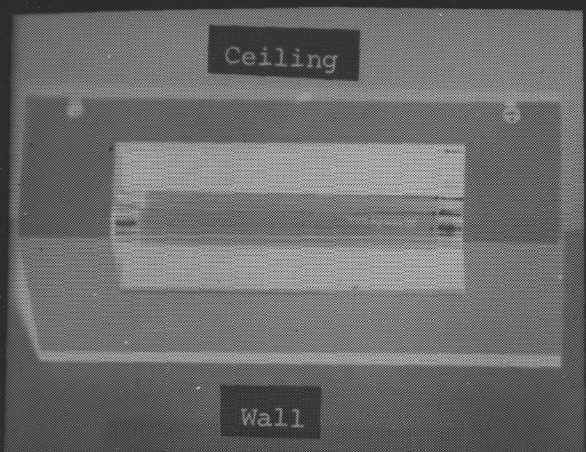
Intruder Detection System

EMERGENCY LIGHT SYSTEM

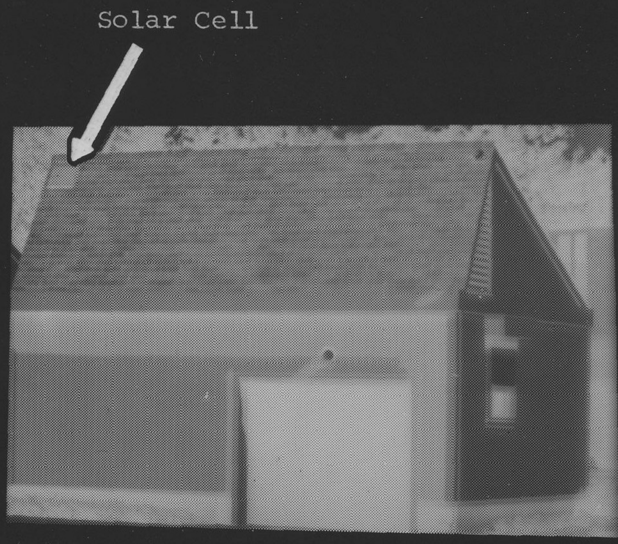
The multimode electronic lighting "Satellight" used in the Tech House emergency lighting system features the high efficiency and long life of fluorescent lamps, as well as extremely high light output for extremely low energy drain. The technology for this system was developed at NASA's Marshall Space Flight Center for providing light for such space vehicles as Skylab. It utilizes low-voltage, high-frequency power generated by self-contained, solid-state electronic lamp drives powered by a 12-volt battery, and is used during times of power failure to provide an even illumination that is more than adequate for safety and security. The battery, charged by a solar cell located on the roof of the garage, powers the system used in Tech House.

The "Satellight" module weighs 2½ pounds; has an aluminum chassis which houses the fluorescent electronic drive, lamp, and wiring compartment; and costs approximately $35.

Manufacturer: UDEC Corporation
223 Crescent Street
Waltham, Massachusetts 02154
Telephone: (617) 899-6400



Emergency Lighting Module



Solar Cell on Garage Roof

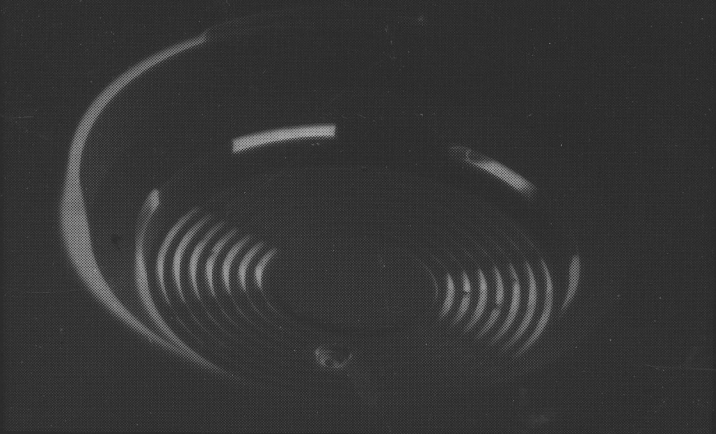
SMOKE DETECTION

The smoke detector used in Tech House is a sensitive detector which senses combustion products before they are noticeable to occupants and, when activated, will sound a horn which will awaken even the soundest sleeper, allowing adequate time for escape from the building. There are approximately 20 brands of smoke detectors on the market, ranging in price from approximately $25 to $85.

There are two types of smoke detectors commonly used in the home: ionization detectors and photoelectric detectors. Ionization detectors use a radioactive source to transform the air inside them into a conductor of electric current. A small current passes through this "ionized" air. When smoke particles enter the detector, they impede the flow of current. Electronic circuitry monitors the current reduction and sets off an alarm when the current gets too low.

Photoelectric detectors have a lamp that directs a light beam into a chamber. The chamber contains a light-sensitive photocell, which is normally tucked out of the way of the lamp's direct beam. But when smoke enters the chamber, the smoke particles scatter the light beam. The photocell now "sees" the light and, at a preset point, sets off an alarm.

Of course, an alarm is only one aspect of a total program of home fire safety which should include fire-prevention measures, fire extinguishers (for small blazes only), and the development of alternate escape routes from the house in case of fire. Information on all these is available from the National Fire Protection Association (470 Atlantic Avenue, Boston, MA 02210), or from your local fire department.

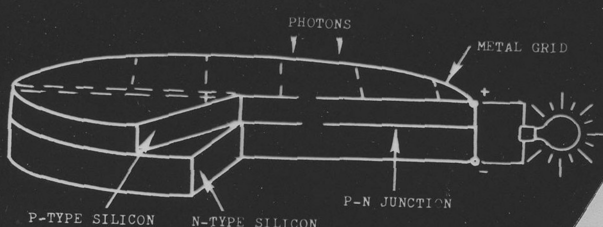


Smoke Detector

AUXILIARY POWER SOLAR CELL

A solar cell is a device for converting light energy into electrical energy without moving parts through a phenomenon known as the "photovoltaic effect." Effective use of the solar cell began when NASA took it out of the laboratory and into limited production by making it the power source for satellites. The most efficient and inexpensive solar cells today are made of silicon, obtained from slicing round silicon ingots. Size is most important, as the power generated is proportionate to the area exposed to light (photon units). While photovoltage is independent of the area, the larger the solar cell, the higher the current will be. A single solar cell charges the Tech House battery which powers the driveway spotlight and the emergency indoor lighting. The cost of the solar cell used in Tech House is $355.

Manufacturer: Solarex Corporation
1335 Piccard Drive
Rockville, Maryland 20850
Telephone: (301) 948-0202



Solar Cell

TORNADO DETECTOR

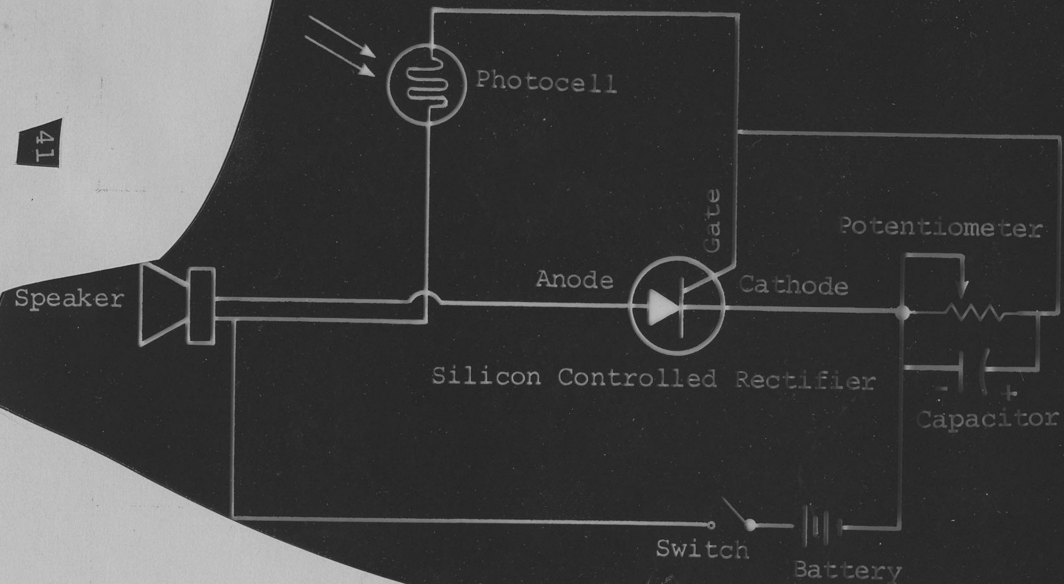
The tornado detector is a light-sensitive device, encapsulated in a suction cup, attached to the television picture tube. For the system to function, the television must be turned to an unused channel with the screen darkened. It is a simple, automatic alarm system that will sound an audible alarm upon the appearance of a tornado within 18 miles. The alarm signal will continue as long as the tornado is within 18 miles.

The device displayed at Tech House was built at NASA's Langley Research Center. A schematic containing a parts list is provided on page 40 for persons that are interested in building a tornado detector. A photograph of the device is shown on page 41.

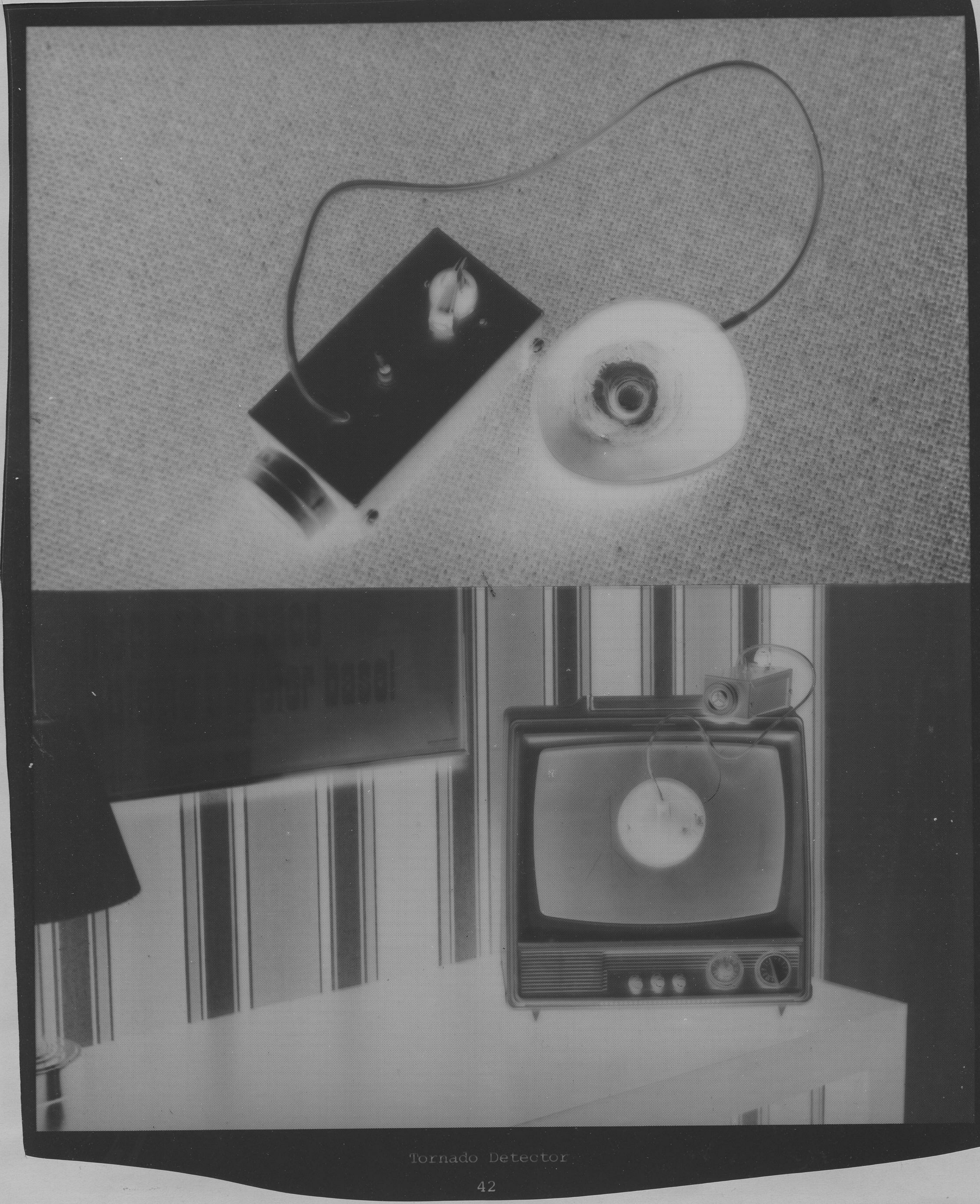
Additional information concerning the tornado detector may be requested from the Technology Utilization Office, Code AT01, NASA Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812, telephone (205) 453-2224.

Note: This concept for tornado detection may not work for tornadoes with insufficient energy transmission.

TORNADO DETECTOR



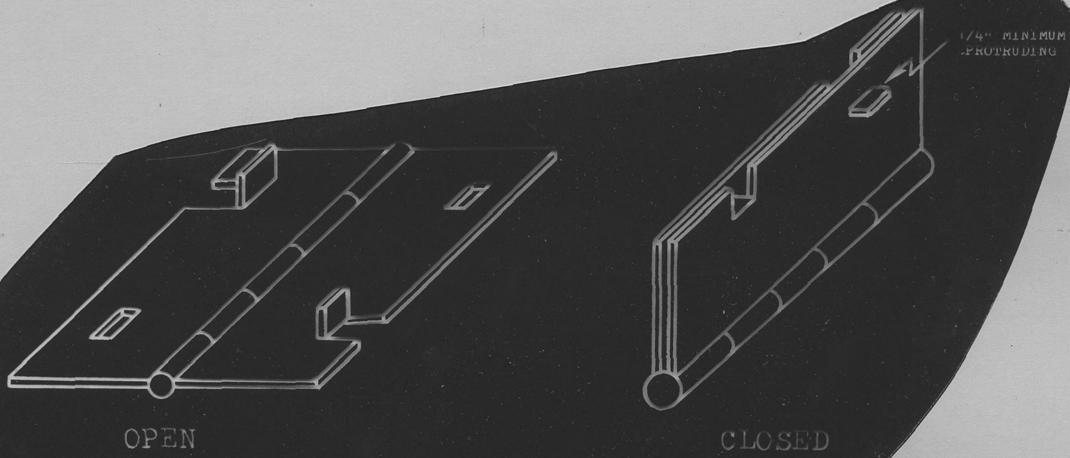
No. Required	Parts (or Equivalent)
1	Silicon Controlled Rectifier, Motorola, 2N5062
1	Photocell, Solar System Inc., Skokie, IL, Dl 12439
1	Potentiometer, 5K Ohm
1	22µF. Capacitor, Tanelectric or Electro
1	Single-Pole Double-Throw Switch
1	9-Volt Battery
1	High-Voltage TV Cup
1	Speaker 6-Volt DC, Mallor Sonaler, 7542
1	Knob, Radio
1	Mini Box, 4" x 2"



Tornado Detector

SELF-LOCKING HINGES

Self-locking hinges were used to secure the outward-opening exterior doors. This hinge was developed at NASA's John F. Kennedy Space Center to provide a mechanical locking device for doors and cabinets with exposed hinge pins. The hinge has dual tabs and slots that lock the hinge side of the door when it is closed to prevent its opening after removal of the hinge pins. The self-locking hinges used in Tech House were fabricated at Langley Research Center.

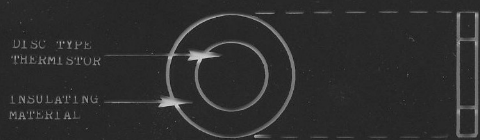


Self-Locking Hinge

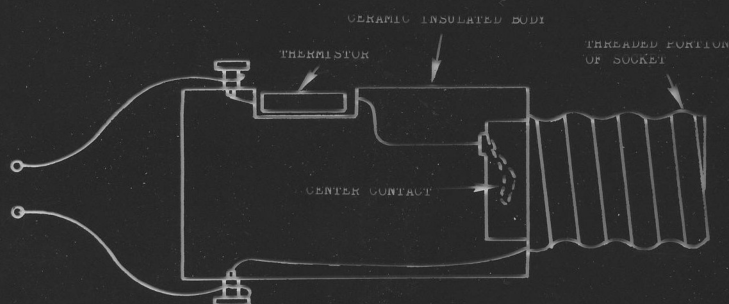
MISCELLANEOUS TECHNICAL BENEFITS

LIGHT BULB SAVER

The temperature-compensating thermistor, developed to protect the Saturn booster from current surges during the Apollo project, serves as an electrical "shock absorber" to shield a light bulb against current surges. These thermistor discs, shown below, were installed in each Tech House light bulb socket to increase the life of the light bulb by at least 300 percent.



The thermistor disc is also available as an Integral Part of Lamp Socket as shown below:



The thermistor disc is available under the trade name "Bulb Miser" at a cost of $1.50. A minimum order of 10 discs is required.

Manufacturer: Bulb Miser, Inc.
P.O. Box 55488
Houston, TX 77055
Telephone: (713) 499-2911

TEMPER FOAM

Temper Foam is used in the seat cushion on the bench between the fireplace and the bookshelves in the living room. It is a flexible urethane foam material, developed to pad seats in the Apollo capsule. With the use of this material, the astronauts were comfortably able to withstand the forces of lift-off and the impact of splashdown. Temper Foam contours to a person's shape and distributes the weight evenly over the contact surface. It reduces fatigue because it absorbs 90 percent of sudden movement or vibration without shock or bounce. It softens with increased humidity and transpires moisture away from the body for cooler sitting comfort. It is ideal for orthopedic application and has been found to be an effective solution to preventing bed sores for persons who are bedridden or confined to extensive sitting. The approximate cost of a cushion 3 by 16 by 18 inches (uncoated and uncovered) is $10.24, while a section 3 by 37 by 81 inches (single mattress size) costs approximately $68.25 when purchased directly from the manufacturer.

Manufacturer: Edmont-Wilson
1300 Walnut Street
Coshocton, Ohio 43812
Telephone: (614) 622-4311

FLAT CONDUCTOR CABLE

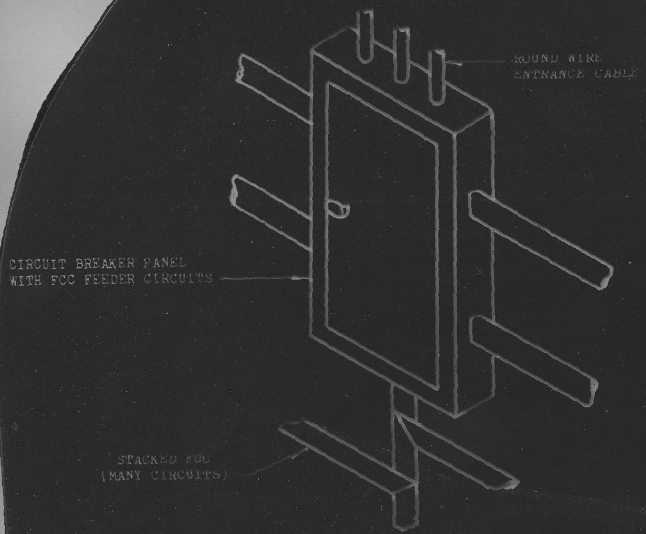
The flat conductor cable (FCC) used in the Tech House living and dining room baseboard is similar to the cable used in the Apollo Lunar Scientific Experiment Package tests and represents technology used extensively in aircraft and spacecraft electrical systems. Rather than conventional round wiring, it resembles three flat wires printed on cardboard and can be installed as shown below. Its major attributes are ease of installation and modification, and requirements for less conductor metal for the same current carrying capacity.

Baseboard System Installation

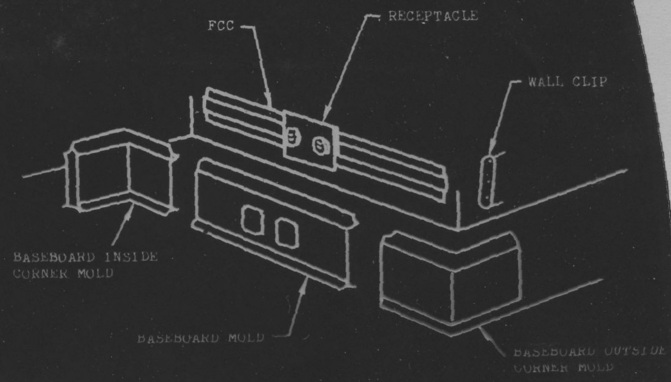
Test installations such as Tech House have brought the FCC system shown on page 36 significantly closer to commercial readiness as a method of reducing the constantly rising cost of installing electrical systems in new and renovated buildings. Further, the flat conductors substantially reduce copper requirements and installation costs. Although the total flat conductor cable system, including baseboard and under carpet use, has not yet been approved by Underwriters Laboratories, the conductor itself is available commercially.

The plastic baseboard covering, receptacles, corner pieces, and end pieces used in Tech House were furnished and installed by Marshall Space Flight Center, Huntsville, Alabama, while the cable itself was supplied by:

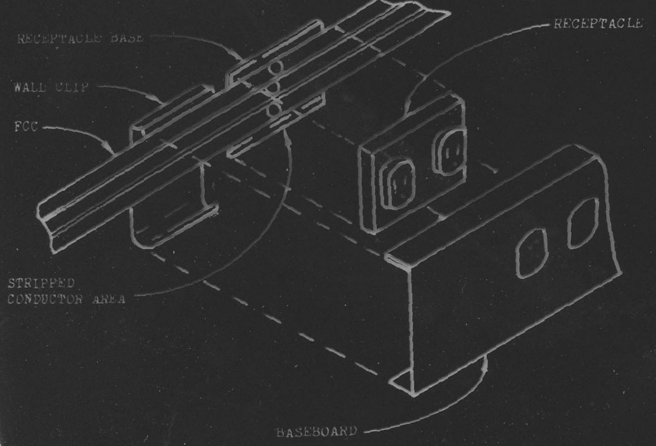
Methuen, Massachusetts 01844
Telephone: (617) 685-4341



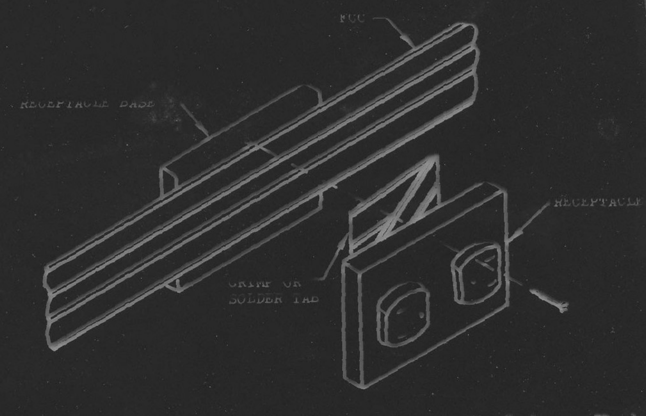
Circuit Breaker Panel



Snap-on Cover Baseboard System



Receptacle with Pressure Contacts



Receptacle with Crimp or Solder Tab

Flat Conductor Cable (FCC) System

PREFABRICATED FLOOR AND WALL

A cast floor is used throughout Tech House, and a cast wall is used between the bathrooms and the master bedroom. These were installed to technically evaluate this form of construction, not because of any price competitiveness in the near future. The floor is a 2-inch, 5000 psi concrete plate, reinforced with welded wire fabric, and insulated with gypsum foam. The floor sections fit in a frame of lightweight steel shapes optimized to produce maximum performance from a minimum quantity of materials. The foam insulation in the floor is noncombustible and costs less than Fiberglas insulation of equivalent thickness.

The prefabricated wall is a glass fiber reinforced gypsum and sand-cast wall mounted on a steel frame. The resultant wall is impact and fire resistant, with a uniform surface. The gypsum foam insulation fills all voids of the wall to reduce heat loss and reduce noise transmission. These floor and wall components are adaptable to conventional trim and finishing materials and were designed for integration with other prefabricated and conventionally built components.

These floor and wall components were procured from the General Electric Company, whose Re-entry and Environmental Systems Division has been developing advanced materials and industrialized technology for use in the construction industry.

This construction can be competitive in price with conventional construction only when prefabricated sections are used throughout the house and several houses are erected at the same time. At this time, this type of construction has not been considered for isolated structures. It was found that when only the floor and a wall are installed in a custom home, as in Tech House, the cost of the crane to position the sections and the cost of drilling the floor for custom plumbing, heating, etc., resulted in increased costs over conventional construction by about three times. It is hoped, however, that results from analysis by NASA may allow a better understanding of its advantages as compared to its present and future price potential.

Information about these products may be requested from:

General Electric Company
Re-Entry and Environmental Systems Division
Product Information
3198 Chestnut Street
Philadelphia, Pennsylvania 19101
Telephone: (215) 835-2669

Placement of Typical Floor Panel

Placement of Double-Cast Wall Panel

FLOOR COVERING

The concrete cast floor is covered throughout the house. The bathroom floors are covered with ceramic tile; the entrance and foyer with slate; the bedrooms, hallway, living and dining rooms with carpet; and the kitchen with a thick foamed-backed sheet vinyl having a urethane coating which has a natural shine requiring minimum care.

The thick-foamed backing provides softness, which reduces the tiring that is associated with constant walking or standing on concrete floors. This floor covering is a GAF Corporation product and is identified as GAF STAR Citation, Santana pattern 50006 (Golden Feather). Additional information can be obtained from a local distributor of GAF floor covering materials or from the following address:

GAF Corporation
Attn: James M. Cloney, Senior Vice Pres.
1101 15th Street, N.W.
Washington, DC 20005
Telephone: (202) 659-9545

HOUSING AND URBAN DEVELOPMENT STUDS

The 2- by 4-inch studs used to frame the interior walls of Tech House were reconstituted from sawdust, thereby utilizing scrap or previously discarded material and reducing new timber cutting. The 2-inch sides of the reconstituted studs were faced with plywood to facilitate nailing.

The Technology Utilization House Study Report, NASA CR-144896, may be purchased from the following address:

North Carolina Science and Technology Research Center
P.O. Box 12235
Research Triangle Park, NC 27709
Telephone: (919) 549-0671

A complete set of drawings and specifications of the Tech House are available for $10 per set from the above address. In addition, reports generated on the operation of the various systems will be available from the above address as they become available.

NASA-Langley, 1977