F601-94CE15611

WhiteCap DOE/ERIP
Progress Report

DOE/CE/15611--T15

October Through December 1996

Task 1: New Construction Demonstration System

Subtask 4. Installation and commissioning of the large WhiteCap system at the Common House was completed in late October, too late for substantive cooling operation this year. The floor slab for the smaller Southwest House, including WhiteCap radiant cooling components (tubing, etc) was poured before year end, but actual construction scheduling was indefinite due to inadequate funding. An O&M Manual was prepared and presented to the building owners to conclude the commissioning process. An unbound copy of that Manual is attached (1), and a "spiral" bound version is enclosed.

Subtask 5. The installed monitoring system was commissioned in October. Unfortunately, meaningful monitoring this year was precluded since by the time monitoring system commissioning was completed cooling demands were insignificant with the onset of heating season.

Task 2: Increased Public And Utility Awareness of WhiteCap Research and Demonstration Results

Subtask 1. Our project officer approved substitution of this task, replacing "Institutional Approvals and Affiliations" in late October. This replacement task with \$12,500 funding, will develop and distribute an informational tool consisting of an Excel-based PC program for WhiteCap design assistance and economics assessment to be called the Simplified WhiteCap Analysis Program (SWAP). Intended for initial distribution to utility and government energy efficiency planners and field representatives, the program will ultimately be offered in multi-media CD Rom format for broad-scale distribution. Preliminary work including investigating DOE2 adaptability for the performance modeling module and review of similar tools to resolve format directions, were initiated before the end of the reporting period. Our October request for the replacement task included a request for extension of our program through March 31, 1996. Planning for completion of the SWAP tool indicates further extension through June 30, 1996 will be required.

Task 3: Expanded Simulations

Subtask 2. Conflicting work commitments prevented further parametric run progress in the reporting period. Runs remained about 50% complete at the end of the period.

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DAVIS
ENERGY
GROUP
INCORPORATED

**Heating & Cooling Systems
Operation and Maintenance Manual**

**Common & Southwest Houses
SCHA Homestead Cooperative
2650 West Eighth Street
Davis, CA 95616**

**Prepared By
Davis Energy Group, Inc.
For
Solar Community Housing Association
&**

ROOF SCIENCE CORPORATION

Exclusively offering

WhiteCap®

Energy Saving Cooling Systems
916-757-4844

November 15, 1996

OPERATION & MAINTENANCE MANUAL

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1. Introduction

This Manual describes operation and maintenance procedures for the radiant heating and WhiteCap™ cooling system installed at the Solar Community Housing Association Homestead Cooperative Common House and Southwest House, located at 2650 West Eighth Street, Davis, CA 95616. The information in this manual is for use by the building owners and building management, maintenance, and technical services personnel. The information in this manual was generated by engineering staff of Davis Energy Group, Inc. (DEG), 123 C Street, Davis, CA 95616, 916-753-1100. DEG was the design engineer for this project, acting on behalf of the building developer, and for Roof Science Corporation with respect to WhiteCap system design and documentation. WhiteCap technology was developed and first demonstrated by Davis Energy Group through a California Energy Commission research project completed in 1992.

This WhiteCap installation, originally proposed in 1994 and completed in September 1996, was partially funded by a US Department of Energy (DOE) commercialization grant awarded on recommendation of the National Institute of Science and Technology, under the Energy-Related Inventions Program. The WhiteCap system is projected to reduce cooling energy use by more than 85% compared to conventional cooling systems.

Owner/Occupant Maintenance as described in this manual must be completed to validate the 20 year (extendable) WhiteCap system warranty. Detailed maintenance recommendations are described in Sections 4 & 5. A one year warranty is provided by the building contractor for heating system components. Component product literature is provided in the Appendix.

2. System Description

2.1 Heating System

The first floor of the Common House is radiantly heated using polybutylene tubing embedded in the concrete slab. A pump circulates hot water from a high efficiency water heater to the three radiant heating zones. Thermostats located in each of the zones independently control temperatures. Zones and thermostat locations are listed in the table below.

Zone No.	Rooms Included	Thermostat Location
1 - West Wing	Bedrooms 1, 2 & 3; Bath 1; Office	Bedroom 1
2 - Common	Dining Room, Kitchen, Laundry, Kids' Room	Dining Room
3 - East Wing	Bedrooms 4, 5 & 6; Bath 2	Bedroom 4

Second floor heating is accomplished by hydronic baseboard heaters located in each room. The baseboard heaters are supplied with hot water from the same water heater that serves the radiant floor. The second floor heating system is also divided into three zones, listed in the table below.

Zone No.	Rooms Included	Thermostat Location
4 - West Bedrms.	Bedroom 1 & 2, Bath 1	Bedroom 1
5 - North Bedrms.	Bedrooms 3 & 4, Half Baths	Hall
6 - East Bedrms.	Bedrooms 5 & 6, Bath 2	Bedroom 6

2.2 Cooling System

The Common House is cooled by a unique system which cools thermal mass (water and concrete) adjacent to interior spaces. This "WhiteCap" cooling system avoids use of refrigerant-based cooling, saving energy and eliminating use of ozone-depleting CFC's.

The WhiteCap system consists of a 3" layer of water over a single-ply roof applied over steel decking, which is exposed to the rooms below. The water layer above the roof deck is insulated by 4" thick styrofoam insulation which floats on the water. Insulation panel edges are grooved and splined together to lock the panels in place. The floating insulation has a hard coating to protect it from sunlight and mechanical damage. Spray heads recessed into the panels are connected to a water distribution system, pump, and filter.

The WhiteCap system cools water by spraying it over the roof surface at night. Evaporation and night-sky radiation typically cool the water to 5° to 10°F below the minimum night air temperature. Concurrently, water is pumped through the floor to cool the concrete slab. The concrete floor and metal deck ceiling (with water above) absorb heat during the daytime to maintain comfortable indoor temperatures. Operation of the cooling system is fully automatic.

Water sprayed over the upper roof levels cascades through raised drains to the lowest roof level. Water evaporated during night spray operation is automatically replaced through a solenoid valve operated by a float switch located at the lowest roof level.

WhiteCap operation is regulated by a microcontroller which determines the amount of spray cooling needed to maintain a "target" water temperature, which is calculated from the daytime maximum temperature. Because WhiteCap cooling is a daily process, cooling is not available "on demand" by changing thermostat settings. See Section 4.3 for a detailed description of controls.

3. System Operation

3.1 Heating System

Selecting Heating Mode. Before the heating system can be operated, the switch on the first floor thermostats must be moved to "heat". To avoid simultaneous heating and cooling of the building all thermostats should be switched to heating at the same time. Thermostats may be set to any desired temperature, and are equipped with battery operated setback clocks to lower the nighttime temperature. Refer to the thermostat owners manual for additional information on thermostat use.

Radiant Heating Thermostat Settings (first floor). Since radiant heating provides equivalent comfort at lower air temperatures than forced-air heating, a temperature setting of 68° to 70°F is recommended. Because of the slow response time of the radiant heating system, the setback period should be retarded by about 3 hours. For example, lowering the temperature at 8 PM and raising the temperature at 4 AM will provide lower temperatures from about 11 PM to 7 AM. To minimize recovery time, the setback temperature should be no more than 5°F below the daytime temperature.

Baseboard Heating Thermostat Settings (second floor). Second floor thermostats may be set at any temperature which provides adequate comfort. Settings of 70° to 72° are recommended. To insure adequate heat output, avoid obstructing air flow around baseboard units by draperies, furniture, or other objects.

Second floor thermostats do not have individual clocks for night temperature setback. However, a timer located in the mechanical room can be used to schedule heating system operation for all second floor rooms. To compensate for building thermal lag, time settings should lead desired temperature changes by at least one hour.

3.2 Cooling System

Since WhiteCap cooling is delivered "passively" through the ceiling and concrete floor, thermostat temperature settings do not affect room temperature in summer. However, first floor thermostats must be set to "cool" for the first floor cooling system to operate. To avoid simultaneous heating and cooling of the building all thermostats should be switched to cooling at the same time.

If a particular first floor zone is receiving too much cooling, the thermostat may be set to "off". There is no corresponding method for limiting cooling to second floor zones.

Computer simulations indicate that the WhiteCap system should maintain indoor temperatures at or below 80°F during hot summer weather. The following measures are recommended to enhance summer comfort:

- Use windows to ventilate rooms and to regulate indoor air temperatures.
- Use fans to increase air movement.
- Use draperies or other shading devices to limit solar gain.
- Minimize use of heat-generating appliances on hot days.

4. Technical and Service Information

Mechanical plans are available to aid service technicians with trouble-shooting and repairs. This section supplements the plans and provides specific information on system operation. Schematics of the heating and cooling system are also included in the Appendix for quick reference.

4.1 Heating System Zone Controls

Thermostats are connected to zone controls (one each for first and second floors) to operate zone valves and pumps. When a thermostat calls for heating the zone control opens the motorized zone valve. When the valve is fully open, an end switch closes, signaling the pump to circulate warm water through the floor (first floor), or through baseboard convectors (second floor). To observe status of zone controls, remove the cover. Green lights indicate the zone is calling for heating. The amber light indicates that one or more of the zone valves is open. When the amber light is lit, the floor circulating pump should be operating.

4.2 Cooling System Zone Controls

During spray cooling operation, the three-way heat/cool valve is energized, allowing the floor circulating pump to draw cold water from the roof instead of hot water from the water heater. An end switch in this valve is used to activate zone valves. Thermostat subbases were modified so that when they are switched to cooling, a 24V signal from the heat/cool valve end switch is conveyed through the thermostat "Y" terminal to the "W" terminal and to the zone control, activating the zone valve and pump. During spray cooling operation all first floor zone valves should be open (green lights all on). To avoid summertime heating, mercury switch cooling leads were disconnected in the thermostats. Should thermostats require replacement, new thermostats and subbases must be modified as indicated in the drawings (Sheet M5.5).

4.3 WhiteCap Controls

WhiteCap control logic is executed by a permanent program residing in controller memory. However, numerous user settings allow modification of program variables such as duration of roof spray and "target" water temperature. Default settings were selected to optimize cooling delivery and minimize energy use. However, experimentation with these settings could result in minor improvements in system performance. It is recommended that Roof Science Corporation be consulted before any modifications to default settings are made. This section describes control functions and operation of the WhiteCap controller in detail.

4.3.1 Control Overview

The WhiteCap controller consists of a Z-World microprocessor with a 2x20 character LCD display, and a 10 button keypad. Three sensors are connected to the controller for measuring outside air temperature, roof water temperature, and water level. Temperature sensors are 10k ohm thermistors and the level sensor has a switched output (open or closed contacts). The controller includes two output relays which control the spray pump and heat/cool valve, and the refill valve. The controller is powered by an external 24 VDC power supply and has an internal battery which will maintain all settings for up to 10 years.

4.3.2 Controller Modes

The controller operates in one of four modes, which are, in order of priority: Manual, Error, Spray, and Idle. Selection of the mode is based on time of day, current air and water temperatures, and settings entered from the keypad.

- **Manual:** Manual mode can only be entered by pressing the *Manual* button. When in Manual mode all other modes are suppressed and the spray pump and fill valve can be individually controlled from the keypad.
- **Error:** Error mode is caused by a failure of one of the temperature sensors, failure of the roof to fill, or an internal controller error. When in Error mode normal operation is disabled and the controller must be reset.
- **Spray:** Spray mode is used to operate the roof spray at night if the roof water requires cooling. At the beginning of Spray mode the controller calculates a water target temperature, estimates the required spray time to attain the target, and starts the roof spray at the appropriate time. At the end of the spray cycle the roof is refilled with water to make up for that lost by evaporation.
- **Idle:** The controller remains in idle mode until any other mode is entered.

4.3.3 Menu System

Controller variables are displayed and adjusted using a menu/item system. All items are grouped into three menus which can be accessed and adjusted using the keypad (see Figure 1). The menus and items are summarized in Table 1.

Figure 1: Controller Keypad Layout

Menu	Item	Field	Up	Down	Help
Status	Manual	Pump	Fill		

Each item in a menu can be displayed and adjusted using the top row of buttons:

Menu	Selects from one of the three menus.
Item	Selects an item from within the selected menu
Field	Moves the cursor within a selected item
Up and Down	Adjusts the value of the selected item
Help	Displays a short description of the selected item

Bottom row buttons have the following functions:

Status	Displays the current mode and summary of controller operation since last reset.
Manual	Enters and exits manual mode. Pressing it twice in a row will reset the controller.
Pump	Turns the spray pump on and off (active in manual mode only).
Fill	Fills the roof with water up to the level of the fill sensor (active in manual mode only).

Table 1: Controller Menu System

Menu	Item	Description	Min	Max	Default
Sensor Status	Outside Air	Current temperature of outside air	Display only		
	Roof Water	Current temperature of water	Display only		
	Level	Status of level switch (OFF = Empty, ON = Full)	Display only		
Spray Inputs	Start Hour	Hour night spray is enabled	12	23	22
	Stop Hour	Hour night spray is disabled	0	11	7
	Max Water T	Maximum water target temperature desired	40	90	65
	Min Water T	Minimum water target temperature desired	40	90	55
	Max Air T	Max Air temp above which target is set to MinWaterT	40	110	80
	Min Air T	Max Air temp below which target is set to MaxWaterT	40	110	60
	Base Rate	Base spray cooling rate in degrees per hour	0	5	1.3
	Rate Coef	Spray cooling rate adjustment per degree of water/air temperature difference	0	5	0.045
Setup	Cur Time	Current Time	N/A		
	Cur Date	Current Date	N/A		
	Air Calib	Air temperature sensor calibration entry	0	120	0
	Water Calib	Roof water temperature sensor calibration entry	0	120	0
	Fill Time	Fill time allowed before error (in minutes)	0	180	120
	On Time	Spray pump on cycle time (in minutes)	0	180	30
	Off Time	Spray pump off cycle time (in minutes)	0	180	5

4.3.4 Controller Operation

Manual Control. Manual mode is entered by pressing the *Manual* button. When the controller is in Manual mode, all other controller functions are disabled and the pump and fill valve can be manually controlled using the *Pump* and *Fill* buttons. Be sure to press the *Manual* button again to return the controller to normal operation when manual control is no longer needed.

Errors. When in Error mode the controller will beep every 3 seconds and display an error message. The error can be one of the following:

Air Sensor Bad or Water Sensor Bad

This indicates that one of the temperature sensors is out of range, most likely due to a break or short in the wiring. Make sure that the sensor wires are securely attached to the controller. Sensor resistance should be on the order of ~10k ohms. The controller will exit this error mode when the sensor is fixed.

Roof Not Filling

This indicates that the last fill cycle lasted longer than Fill Time before the roof filled. This could be caused by Fill Time not being set long enough, a failure in the fill valve, a failure in the level sensor, or a leak in the system. This error must be reset by pressing the *Manual* button twice to initialize the controller.

Program Error ___ at ___.

This is a program error and indicates an internal problem with the controller. Note the error numbers and call for service. This error must be reset by pressing the *Manual* button twice to initialize the controller.

Roof Spray. Spray Mode is active only when the current hour is between Start Hour and Stop Hour. The Spray Mode has four steps, summarized in Table 2.

Table 2: Spray Mode Sequence

	Status Message	Function
Optimized Start	Spray Start at HH:MM	<ul style="list-style-type: none">The water target temperature is calculated from the maximum air temperature for the day using the function shown in Figure 3.If the water temperature is above the target temperature then the spray time required to attain the target temperature is calculated and the spray cycle is scheduled to start at the optimum time.
Spray	Spraying	<ul style="list-style-type: none">The pump is turned on for "On Time" minutes.
Drain	Letting Roof Drain	<ul style="list-style-type: none">The pump is turned off for "Off Time" minutes to let the roof water levels equalize.
Fill	Roof at Target Temp	<ul style="list-style-type: none">The pump is turned off when Stop Hour is reached or the water temperature reaches the target.The fill valve is turned on and the roof is refilled to the level of the fill sensor.

Fig.1: Tank Target Calculation Curve

Calibration. The temperature sensors can be calibrated using the following steps:

1. Place a reliable (calibrated) temperature probe in the same location as the sensor to be calibrated and allow the reading to stabilize.
2. Locate the appropriate Calib item in the Setup menu.

3. Enter the probe temperature reading using the *Field*, *Up*, and *Down* buttons.
4. Press the *Menu* button.
5. The sensor reading should now match the probe reading.

Status. Pressing the *Status* button displays the following:

- The current mode and status
- The firmware version.
- The elapsed time since last reset.
- The average spray pump time in hours per day.
- How long it took to last fill the roof.
- The maximum air temperature for the previous day.
- The water target for the previous day.

5. Routine Maintenance

5.1 Heating System Maintenance

The WhiteCap cooling system provides the water supply for the heating as well as the cooling system. The heating system therefore requires no periodic water addition to maintain operation. All pumps are water-lubricated and require no service.

5.2 Cooling System Maintenance

The WhiteCap system must be maintained to preserve operating efficiency and to prevent voiding the system warranty.

Filter Maintenance. The filter must be cleaned each month during the cooling season (May through October). If only a small amount of dirt accumulates, cleaning may be extended to every other month. The filter is located in the mechanical closet. A maintenance log is provided with this manual and should be used to enter dates that the filter is cleaned.

To clean the filter, close the isolation valves on each side of the filter (see schematic in Appendix), attach a hose to the drain at the base of the filter, and open the drain valve. Then unscrew the large wing nut at the top of the filter, remove the lid, and lift out the filter media. Use a hose (connected to the laundry tub faucet) and a spray nozzle to flush away dirt and debris. Replace the filter media and lid, insuring the o-ring seal is properly positioned, and secure the lid. Close the filter drain and open the two isolation valves. (Failure to open the valves could damage the pump.) Observe after several minutes to verify that the o-ring and drain seals are not leaking.

If the filter media requires replacement, replace only with media specifically designed for the Hayward Model C-1100 filter. Refer to the Hayward filter maintenance manual for further information.

Spray Head Maintenance. Inspect spray heads at the beginning of each season to insure they are not clogged. The manual control mode may be used to start the pump so that the heads may be inspected during spray operation. To clean the heads, use a sprinkler head wrench to hold the flange and another wrench to remove the spray nozzle. Do not rotate the flange. Use a wire or other sharp tool to remove debris, and blow out with air or water. Replace the nozzles and operate the pump to insure heads are spraying properly.

The floating insulation will support light foot traffic. However, access to the roof must be limited to persons performing maintenance, and weighing less than 175 pounds.

Insulation Panel Maintenance. Insulation panels should be inspected annually to insure that the white protective coating has not been damaged or chipped away, exposing the blue insulation beneath. Contact Roof Science Corporation if repairs are needed.

5.3 Requesting Service

Heating & Cooling Systems. Contact Hunt Associates at (916) 756-4966 for problems with heating system components, and Roof Science Corporation (757-4844) or Davis Energy Group (753-1100) for problems with cooling system components.

Roof Spray System. Roof Science Corporation should be contacted to resolve any problems with the spray cooling system and controls. A control failure will usually be announced by an intermittent beeping sound from the microcontroller located in the mechanical closet.

Roof Membrane. The roof membrane is guaranteed for ten years by Seaman Corporation and for an additional ten years by Roof Science Corporation per the warranty documents included as Appendix C. Contact Roof Science Corporation at 757-4844 or Pacific Single Ply, Inc. at 757-2651 if a roof leak develops. If roof leaks are aggravated by the roof spray system, disable the spray controls by setting them in manual mode as described in Section 4.3. For roof membrane manufacturer warranty service contact Seaman Corporation at 800-927-8578.

6. EMERGENCY PROCEDURES

6.1 Water Leakage from the Roof

Water may be rapidly drained from the roof sections. To drain the lower two roof sections, locate the 2" plastic drain valve in the mechanical closet, attach the corrugated drain line provided, and open the valve.

To drain the upper roof sections, refer to the attached roof plan for drain locations. Unscrew the drain pipes by rotating counter-clockwise. Water will drain to the lower roof sections and out the drain in the mechanical room.

6.2 Water Leakage from Mechanical Closet Equipment

Locate the 2" plastic drain line on the upper left side of the mechanical closet and close the PVC ball valve by rotating the handle until it is perpendicular to the pipe. Also close the 1" brass ball valve in the tee just above the 2" valve. These valves isolate mechanical room piping from water on the roof, allowing drainage and repair without draining the roof. Table 3 summarizes locations of both water and electrical shut-offs.

Table 3: Equipment Shut-offs

Shut-off	Location
Roof Drain	PVC ball valves on the wall above the filters.
Refill Water Supply	Ball valve on the water supply line.
Pump Power	Disconnect switches on the wall above the pumps.
Valve and Pump Contactor Power	24 VAC transformer inside the controller cabinet.
Controller Power	Wall-pack transformer inside the controller cabinet.

6.3 Fire

In the event of fire, the roof spray system can be used to protect the roof from fire damage. Remove the cover from the control box in the mechanical closet and locate the microcontroller. Press the "Manual" button, followed by the "Pump" and "Fill" buttons. To restore normal operation press the "Manual" button again.

APPENDIX A

**HEATING & COOLING SYSTEM DRAWINGS
&
EQUIPMENT SCHEDULES**

HEATING SYSTEM SCHEMATIC

BUILDING PLAN SHOWING ROOF DRAIN LOCATIONS

COOLING SYSTEM SCHEMATIC

COOLING SYSTEM CONTROLS

HEATING SYSTEM CONTROLS - FIRST FLOOR

HEATING SYSTEM CONTROLS - SECOND FLOOR

EQUIPMENT SCHEDULE

Symbol	Spescification
ZV	ZONE VALVE, ERIE 0765C0008GA01, 3/4" SWEAT, 2-WAY, 24VAC, 3.7 Cv, WITH END SWITCH. QTY: 6
CV	HEATING/COOLING CHANGEOVER VALVE, ERIE 0765C0036GA00, 3/4" SWEAT, 3-WAY, 24VAC, 6.0.Cv.
BB	BASEBOARDS - ARGO LO-TRIM. SEE DRAWINGS FOR QUANTITIES.
WHA	WATER HAMMER ARRESTOR - PRECISION PLUMBING PRODUCTS PPSC750
RV	SOLENOID REFILL VALVE - DAYTON 1A578
WH1	AMERICAN "POLARIS" PBG102-50T100-2N, 50 GAL., 100,000 BTUH NATURAL GAS INPUT, 94% RECOVERY EFFICIENCY, 120V, 80W
P1	FLOOR CIRC. PUMP - TACO 0011BF1, 1/9 HP, 115/230V, 1 PH, BRONZE, 6.8 GPM @ 26 FT HD.
P2	BASEBOARD CIRC. PUMP - TACO 006B3, 3/4" FLANGE, 1/40 HP, 0.68A, 4 GPM @ 6 FT HD.
P3	SPRAY PUMP - HAYWARD PU/HD-SP3007, 3/4 HP, 2", 115/230V, FULL RATED, 33 GPM @ 56 FT. HD.
T1-T3	THERMOSTAT, WHITE-ROGERS 1F76-357, HEAT/COOL, ELECTROMECHANICAL SETBACK, BATTERY BACKUP. SEE DRAWINGS FOR SUBBASE MODIFICATIONS.
T4-T6	THERMOSTAT, HONEYWELL T87F2873, HEATING ONLY.
C1	ZONE VALVE CONTROL, ARGO AZ244P, 4 ZONES, 24VAC
C3	ZONE VALVE CONTROL, ARGO AZ243, 3 ZONES, 24VAC
L1	Z-WORLD "C-PLC" MICROCONTROLLER

APPENDIX B

MANUFACTURER'S EQUIPMENT LITERATURE

SEAMAN CORPORATION— ENGINEERING HIGH PERFORMANCE MEMBRANES FOR 45 YEARS

Seaman Corporation is a high technology company that has devoted itself exclusively to the development of reinforced membranes for high performance applications. Nearly all the major technological improvements in synthetic architectural fabrics for the past four decades have come from our laboratories. Our passion for perfection has led us to expand our manufacturing operations to include the entire manufacturing process from raw fiber to weaving to coating to finished product. We've learned that this is the only way we can assure our customers of the finest consistent quality at competitive prices. The ability to provide this unparalleled value is why we're growing as quickly as we are.

We're proud to be members of the professional roofing industry and our commitment to excellence is expressed by participative membership in such respected organizations as the National Roofing Contractors Association (NRCA), Single Ply Roofing Institute (SPRI), Roof Consultants Institute (RCI) and the Architectural Fabric Structures Institute (AFSI). Through these associations, we will continue to improve roofing technology and our own system, living up to both our inherited Seaman reputation of outstanding quality and achievement as well as our marketing promise of unequalled customer satisfaction and service.

Fiberlite
SINGLE PLY ROOF

1000 VENTURE BOULEVARD
WOOSTER, OHIO 44691
(216) 262-1111
FAX (216) 263-6950
1 (800) 927-8578

APPENDIX C

ROOF/COOLING SYSTEM WARRANTIES

WARRANTY FOR COMMERCIAL ROOFING

SCHA

4,200

Building Owner's Name

2525 Westernneese Road, Davis, CA.

Building Owner's Address

SCHA, 2650 W. 8th Street, Davis, CA.

Address or Location of Building

Area of Roofing Project

Seaman Corporation

Seaman Corporation Inspector

07 - 25 - 1996

Date of Completion and Acceptance

SEAMAN CORPORATION warrants to the owner named above ("Owner") of the building described herein that, subject to the Terms, Conditions, and Limitations set forth below, for a period of **Ten (10) years** commencing with the date of final inspection and acceptance, Seaman Corporation will repair any leaks in the FiberTite Roofing Systems furnished to said commercial building attributable to Roofing Membrane provided by Seaman Corporation and/or defective workmanship provided by Seaman Corporation or its authorized FiberTite Single Ply Roof Applicator.

Terms, Conditions & Limitations

1. The Roofing System must have been installed by an Authorized FiberTite Single Ply Applicator and must have been inspected and approved for warranty by Seaman Corporation. This warranty issuance will not relieve the installation contractor from performing additional work should final inspection discover any failure to comply with Seaman specifications or shortcomings in workmanship.
2. Throughout the term of this warranty, Seaman Corporation shall be given free access to the roof of the commercial building described herein during regular business hours.
3. The Owner shall obtain Seaman Corporation's prior written approval before making any alterations of said roof or installing any structures, fixtures on or through said roof.
4. Seaman Corporation shall have no obligation under this warranty until all bills for installation, supplies and service have been paid in full to the Authorized FiberTite Single Ply Roof Applicator and any material suppliers, including Seaman Corporation.
5. Owner shall give Seaman Corporation written notice at its address set forth herein not more than thirty (30) days after discovery of any leaks in the Roofing System.
6. If, after inspection by Seaman Corporation, leaks in the Roofing Membrane System are found, in good faith determination of Seaman Corporation, to be the result of defects in the Roofing Membrane provided to the Owner by Seaman Corporation and/or the workmanship provided by Seaman Corporation and/or Authorized FiberTite Single Ply Roofing System Applicator, Seaman Corporation will repair any leaks in the Roofing System at its expense, but in no event shall Seaman Corporation's obligation over the lifetime of the warranty exceed the Owner's original cost of the installed roof.
7. The Owner will be responsible for the cost of investigation if any leak is determined not to be covered by this Agreement.
8. The warranty stated herein is the SOLE AND EXCLUSIVE REMEDY for failure of the Roofing System. SEAMAN CORPORATION SHALL UNDER NO CIRCUMSTANCES BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING BUT NOT LIMITED TO DAMAGES TO OTHER COMPONENTS OF THE ROOF, THE COMMERCIAL BUILDING DESCRIBED HEREIN OR THE CONTENTS OF SAID BUILDING.
9. This warranty shall not be applicable to nor shall Seaman Corporation be responsible for damage or loss caused in whole or in part by: natural disasters including, but not limited to lightning, hurricanes, tornadoes or earthquakes; vandalism, civil disobedience or acts of war; alteration of the roof or installation of structures, fixtures or utilities on or through the roof without the prior written approval of Seaman Corporation as previously stated in section three (3); settling, warping, defective condition, corrosion, or other failure of the structure or substrata to which the Roofing System is attached; any chemical contaminants injurious to the Roof System that have not been specifically approved by the company via the Materials Submittal & Warranty Request form; negligence or failure by the Owner or any lessee to reasonably maintain the roof; traffic or storage of materials on the roof, infiltration or condensation of moisture in, through, around or above the walls of the building; acts of negligence or misuse by the Owner or any other party other than Seaman Corporation, or an Authorized FiberTite Single Ply Roof Applicator; and/or failure of any material or component not furnished by Seaman Corporation.
10. This agreement may be assignable to a subsequent building Owner, only if the above named owner requests in writing that Seaman Corporation consent to an assignment of this warranty to the purchaser of the building from Owner, which consent will not be unreasonably withheld.
11. SEAMAN CORPORATION MAKES NO WARRANTY THAT THE ROOFING SYSTEM IS MERCHANTABLE OR FIT FOR ANY PARTICULAR PURPOSE, THERE BEING NO WARRANTIES, EXPRESS OR IMPLIED, WHICH EXTEND BEYOND THE FACE HEREOF. NO EMPLOYEE OR REPRESENTATIVE HAS AUTHORITY TO MAKE ANY REPRESENTATIONS OTHER THAN THOSE STATED HEREIN.

Building Owner's Signature

See Reverse Side

Warranty Exclusions

See Reverse Side

Warranty Inclusions

By: Terry L. Anderson **SEAMAN CORPORATION**
Title: NATIONAL SALES MANAGER Date: 7-6-96

Note: Roofing installations for personal, family or household purposes ARE NOT WARRANTED HEREUNDER.

Serial No. 96 - 191

1000 VENTURE BLVD. * WOOSTER, OH 44691

FiberTite® Single-Ply Roof System

Exhibit "A" / Warranty No. 96 - 191

Requirements

Under the "*Terms, Conditions & Limitations*", paragraph (9), of your Seaman Corporation commercial roofing warranty, reference is made toward the responsibility of the owner to reasonably maintain the roof.

The FiberTite Single-Ply Roof Membrane will not require any special maintenance but your "roof system" which includes metal flashings, terminations and sealants, will require periodic maintenance to insure against harmful water penetration.

Specific Items of Maintenance for Warranty No. 96 - 191 will include:

1) Water Ballast : The water ballast is the method chosen to keep the roof system intact. Failure to maintain the proper amount of pressure on the roof system and any subsequent problems associated with the improper amount of ballast is not the responsibility of Seaman Corporation

In addition to the above, common maintenance will include keeping the roof free of debris, keep drainage systems free flowing, and limit roof traffic to service personnel only.

For additional information pertaining to roof maintenance, refer to the FiberTite Single-ply Roofing System Maintenance Program, included in your warranty package or contact the FiberTite Technical Service Department at : 800/ 927-8578

By: Jonathan C. Pierson
Title: FiberTite Technical Services

Date:

ROOF SCIENCE CORPORATION

123 C Street
Davis, CA 95616

Tel: 916-757-4844
Fax: 916-753-4125

Serial No.: WCR/F-0001-SCHA-CH

WhiteCap System Warranty

Owner: Solar Community Housing Association
2525 Westernese Road
Davis, CA 95616

Building: SCHA Homestead Cooperative
2650 West Eighth Street
Davis, CA 95616

Final Inspection/RSC Acceptance Date: November 15, 1996

Initial and Extended Warranty. Roof Science Corporation (RSC) a California Corporation warrants to the Building Owner (Owner) of the above described building, that subject to the Terms, Conditions and Limitations stated in this warranty, RSC will cause any leak to be repaired and/or any WhiteCap System (System) defect to be remedied, for an initial period of twenty (20) years from the date of final inspection and acceptance of the System by RSC. RSC will extend the initial warranty for up to thirty (30) years at a cost of \$.15 per square foot of roof surface per year, payable annually not later than thirty (30) days prior to the first day of each successive year for which extended coverage is desired.

Covered Components. This warranty includes the following System components for the building described above: (a) membrane system including seals, (b) coated insulation panels, (c) spray piping system, (d) filter/pump system, (e) control system.

Terms, Conditions, Limitations

Notice. Owner shall notify RSC in writing within thirty (30) days of discovery of any defect in the System. Owner shall send such written notice to RSC, Attention Warranty Claims, at the address at the top of this warranty form.

Inspection and Remedies. If, upon inspection by RSC, RSC determines the defect is caused by defective System materials or components, or workmanship of RSC approved contractor(s), Owner's remedies and RSC's liability shall be limited to RSC's repair of the defect. However, RSC's obligation over the life of the System shall not exceed Owner's original cost of the installed System.

Exclusions. This warranty shall not be applicable if, upon RSC's inspection, RSC determines that any of the following has occurred: (a) the System is damaged by natural disasters, including, but not limited to, lightning, fire, earthquake, tornado, hail, hurricanes and winds of peak gust speeds of 80 mph or higher measured at 10 meters above ground; or (b) the System is damaged by any acts of negligence, accidents or misuse, including, but not limited to, vandalism, civil disobedience, acts of war; or (c) the System is damaged as a result of deterioration or failure of building components, including, but not limited to, roof deck, walls, mortar, HVAC units, etc.; or (d) acids, oils, harmful chemicals and the like come in contact with and cause damage to the System.

Warranty Null and Void. This warranty shall be null and void if any of the following shall occur: (a) if, after installation of System by an approved RSC contractor, alterations, repair or remodel of other building features caused damage to System components, or (b) failure by the owner or lessee to use

reasonable care in maintaining the System, said maintenance to include, but not be limited to, those items listed in the WhiteCap Operating and Maintenance Manual provided on completion of System commissioning, or (c) Owner fails to comply with every term or condition stated herein.

Warranty Service Access. During the term of this warranty, RSC, its agents or employees shall have free access to System components during regular business hours. All inspections, and work conducted under terms of this warranty shall be performed during regular business hours.

Full Payment. RSC shall have no obligation under this warranty until all bills for installation, supplies, service and warranty charges have been paid in full to the RSC approved contractor, RSC, and materials/components suppliers.

Replacement Parts. All replacement parts, whether new or remanufactured, assume as their warranty period only the remaining time period of this Warranty.

Waiver. RSC's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.

Sole Warranty. This warranty supersedes and is in lieu of any and all other warranties that are in conflict with the terms and conditions stated herein.

The remedies stated herein are the sole and exclusive remedies for defects or failure of the WhiteCap System. There are no warranties, either expressed or implied, including implied warranties of fitness for a particular purpose and merchantability, which extend beyond the face hereof. RSC shall not be liable for any incidental, consequential, or other damages including, but not limited to, loss of profits or damage to the building or its contents, under any theory of law whatsoever.

Roof Science Corporation

By:

Richard C. Bourne, PE, President

Date: November 15, 1996