DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150802

INSTALLATION PACKAGE FOR SUNPAK™ SOLAR COLLECTORS

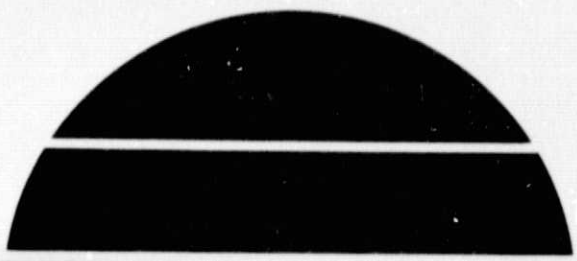
Prepared from material furnished by

Owens-Illinois, Inc.
P. O. Box 1035
Toledo, Ohio 43666

Under Contract NAS8-32259 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

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1. Installation Instructions.

The SUNPAK™ SEC-601 air cooled collector is modular in design. The module is shipped to the distributor/installer as sub assemblies because of shipping volume and cost considerations. The module is partially preassembled at the factory and tested for mechanical integrity and air leakage flow rate prior to packaging for shipment.

The Model SEC-601 collector is twelve feet-two and three-fourth inches in width and eight feet-seven inches high. The module contains 72 collector tube elements mounted on four inch centers. The total module weight is 300 pounds and with the collector tube elements removed 80 pounds. The surface to which the collector module is mounted can deviate from a single plane surface by the order of 1" per 12' with no impact on collector thermal performance or service life. The module design has emphasized minimum air leakage, a characteristic of utmost importance in the attainment of high thermal performance of a solar energy system. The system installation should also emphasize a low level of air leakage for the same performance considerations.

The subassemblies received by the distributor/installer are:

1. Tube Assembly:P/N SK-3555
2. Return Tube: P/N SK-5089
3. Manifold Assembly: PN SK-5076
4. Rail Subassemblies (All angles etc., factory assembled)
5. Outboard Support Subassemblies (All possible parts factory assembled)
6. Tube Retainer (cushion factory assembled)
7. Hardware (just nuts and bolts - one size

The subassemblies or components provided by the distributor/installer include:

Alcoa - Bone white background.
Mounting screws for background.
Mounting hardware for collector.
Mating roof penetration.

The Model SEC 601 Collector module is designed for assembly (less collector tube elements) by the distributor/installer near the site of the collector installation. The assembly procedure starts with the placement of the five (5) T bars (P/N SK-5085) in parallel allignment on approximate three (3) feet centers per mounting diagram. The two (2)

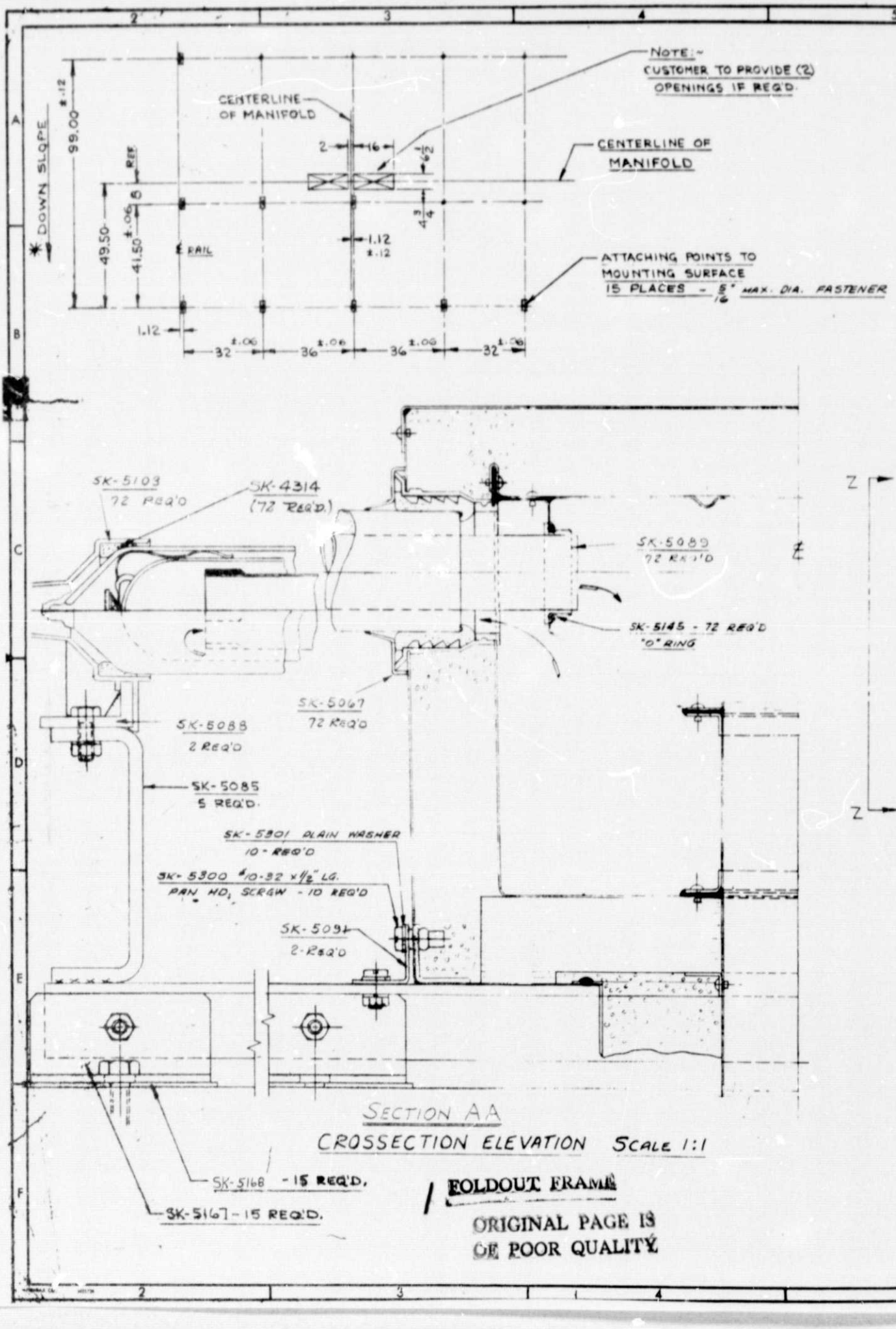
tube end support units (P/N SK-5088) and the manifold (P/N SK-5076) are placed upon the T bars and secured in place by hardware; nut (P/N SK-5303) and bolt (P/N SK-5300), plain washer (P/N SK 5301) and lockwasher (P/N SK-5302). The holes are pre-drilled at the factory to insure the allignment of subassemblies. The completed manifold and support structure subassembly is shown in SK-5075.

The roof (installation) site of the collector is prepared for collector mounting by completing the roof penetrations to mate with the manifold transition ducts. The Alcoa Bone White K 2028-30 (or equivalent) diffuse reflecting backing screen is pre mounted in accordance with the recommendations of the supplier.

The completed manifold/support structure subassembly is lifted to the roof (installation site) and positioned to line up and insert the manifold transition ducts into the roof penetration ducts. After suitable positioning of the manifold transition elements, the module support structure is attached to the Alcoa Bone White (or equivalent) backing surface using Molly hardware (or equivalent). All roof penetrations are then sealed for weather tightness.

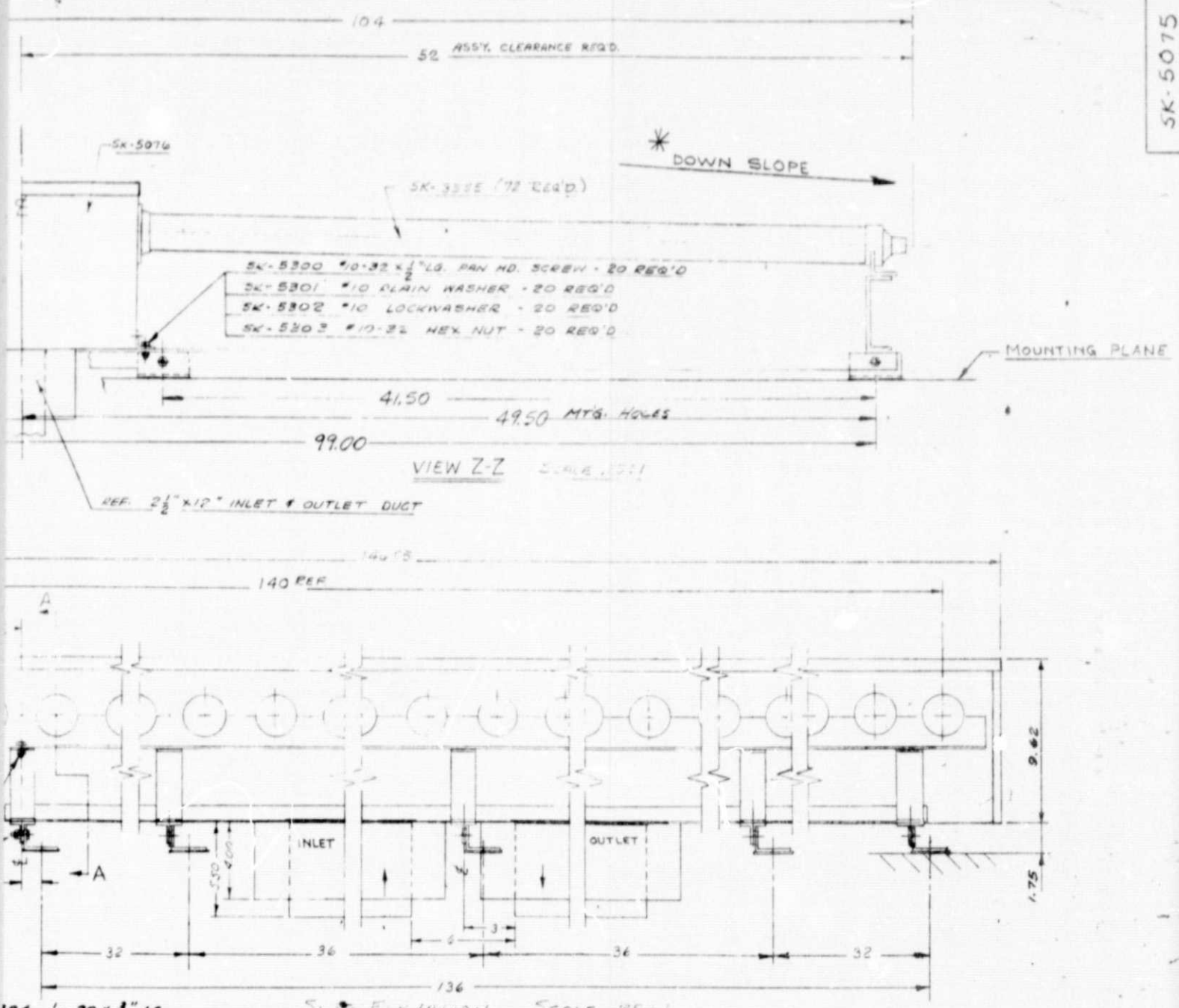
The collector module installation is completed by the insertion of the return tubes (P/N SK-5089) and the Tube Assemblies (P/N SK-3555) into the manifold (weather seal SK-5067). The Tube Retainer (P/N SK5103) is snapped into place to complete the assembly of the individual collector tube elements. The order of assembly of the tube elements is not critical.

Upon completion of the system ducting and installation of the air fan, it is recommended that the system be tested for air leakage. This may be accomplished by sealing off the duct which would normally connect to the fan inlet. A smoke bomb is ignited and the smoke effluent ingested into the fan inlet with the fan operating under essentially maximum pressurized conditions. Air leakage is detected visually. The smoke bomb, model K-30-Y Yellow Smoke Candle, manufactured by Kilgore Corp., Toone, TN produces a smoke which is yellowish in color and which leaves a yellow deposit on any surface scrubbed by the significant concentration of the smoke. It is suggested that the smoke bomb system test be conducted prior to the application of insulation to the ducting in order to pin point the location of any air leakage condition.



FOLDOUT FRAME

SK-5075



104 1/4-20 x 1/2" LG. HEX HD. SCREW - 25 REQ'D

305 1/4" LOCKWASHER 25 REQ'D

306 1/4" HEX NUT 25 REQ'D

SIDE ELEVATION SCALE: .25 : 1

ECN 2002				
C	CHG. UPDATE	S.L.	3/10/78	
B	RELEASED	S.L.	1/31	
A	ADD'L NOTES REVISED	G.L.	11/17/77	
CHG.	DESCRIPTION	BY	DATE	MF

USED ON ASSEMBLY NO.

TOLERANCE UNLESS OTHERWISE NOTED	2 PLACE DEC. ±	DEFINITION OF SYMBOLS (Total Indicator Reading)	SCALE NOTED: INCHES	OWENS-ILLINOIS	PROJECT NO. C-2370
	3 PLACE DEC. ±		MATERIAL		DES'D
	ANGLES ±	CONCENTRICITY			DR'N
CORNERS AND/OR EDGES BROKEN	OUTSIDE RAD. MAX.	ROUNDNESS	HEAT TREAT		CK'D
	INSIDE RAD. MAX.	FLATNESS	CASE DEPTH	CORPORATE TECHNOLOGY TOLEDO, OHIO	SOLAR COLLECTOR MODEL SEC-631
UNLESS SPECIFIED, MACHINED SURFACE ROUGHNESS NOT TO EXCEED √	RADII UNLESS OTHERWISE NOTED	SYMMETRY	HARDNESS		NUMBER SK-5075
		PARALLEL	SUR. TREAT		SHEET 1 OF 1
		PERPENDICULAR			SIZE D

					SK-5075	D	Solar Energy Collector System
							ORIGINAL PAGE IS OF POOR QUALITY
72					SK-3555	C	Tube assembly
	1				SK-4348	B	Cover Tube
	1				SK-4349	B	Absorber Tube
	1				SK-2356	A	Vacuum Extension
	1				SK-3105	A	Tip-Off Protector
	1				SK-4305	A	Spring and Getter Assembly
		1			SK-4346	A	Getter
		3			SK-4347	A	Spring
	1				SK-5065	B	Seal-Tube
72					SK-5089	B	Return Tube Assembly
	1				SK-5090	B	Nut
72					SK-5145	A	"O" Ring 1-5/16" I.D. x .139" diameter
72					SK-5067	B	Seal Retainer
72					SK-5103	C	Retainer-Tube
	1				SK-4314	A	Cushion
5					SK-5085	C	Rail Assembly
	1				SK-5086	C	Rail
	2				SK-5087	B	Spacer
2					SK-5088	C	Support-Outboard
2					SK-5091	C	Stop-Manifold
15					SK-5168	A	Roof Pad
15					SK-5167	A	Roof Bracket
30					SK-5300	A	#10-32 x 1/2" lg. Pan Hd. Slotted - St. Stl.
30					SK-5301	A	#10 Plain Washer, St. Stl., .437 O.D. x .208 I.D. X .049 TK
20					SK-5302	A	#10 Spring Lockwasher St. Stl.
20					SK-5303	A	10-32 Hex. Nut St. Stl.
25					SK-5304	A	1/4-20 x 3/4" lg. Hex. Hd. Cap Scr. Alum.
25					SK-5305	A	1/4" Spring Lockwasher St. Stl.
25					SK-5306	A	1/4-20 Hex. Nut Alum.

1					SK-5076	E	Manifold Assembly Complete
	1				SK-5577	C	Manifold Shell Assembly
		2			SK-5560	B	Insulation Cover
		1			SK-5077	C	Manifold-Welded
			1		SK-5092	C	Shell-Manifold
			2		SK-5093	B	End Cap-Manifold
			10		SK-5107	A	Clip
			10		SK-5108	A	Rivnut
	1				SK-5576	C	Cold Duct Assembly
		1			SK-5078	C	Cold Duct- Welded
			1		SK-5095	C	Cold Duct
			2		SK-5079	C	End Assembly-Cold Duct
				1	SK-5097	C	Flange-Hot Duct
		1			SK-5080	C	Inlet Duct Assembly
			1		SK-5574	B	Flange-Center
		1			SK-5081	C	Outlet Duct Assembly
			1		SK-5099	B	Flange-Top
			1		SK-5574	B	Flange-Center
		1			SK-5104	C	Insulation-Bottom
		2			SK-5106	A	Insulation-End
		2			SK-5575	B	Flange-Lower
		56			SK-5170	A	3/32" Alum. "Pop" Rivit
	72				SK-5066	B	Spacer Cup
	72				SK-5064	B	Retainer Cup
	1				SK-5094	B	Cover-Manifold
	1				SK-5098	C	Hot Duct
	1				SK-5096	C	Cover-Hot Duct
	178				SK-5170	A	3/32" Alum. "Pop" Rivet

2. Operating Instructions.

The SUNPAK™ Model SEC-601 air cooled collector is modular in design. A single module contains 72 collector tube elements. All collector tube elements are mounted into the manifold so as to induce a parallel air flow pattern in all collector tube elements. The pressure drop vs air flow rate for a single module is indicated in Figure 1. The pressure drop represents the difference in static pressure measured in the inlet and outlet transition sections between the manifold and the system air ducts. Thus, the air flow versus pressure drop information applies to any number of modules installed to constitute a large collector array providing the system ducting introduces no significant pressure drop due to flow in the ducting.

The Model SEC 601 air cooled collector is virtually free of limitations to operating conditions. The collector module has been tested under air flow rates and system operating pressures beyond any conceivable practical operating conditions. As in all solar thermal collectors, thermal performance is affected by the rate of flow of the cooling fluid. Thus, air mass flow rates below 6 LBS/Hr. FT.^{2} are not recommended because of the attendent decrease in thermal performance which is observed. Similarly, air-mass flow rates above 20 LBS /Hr. FT.^{2} are not usually recommended because of air pumping power requirements. It should be noted, however, that such flow rate recommendations are based on system considerations; no adverse conditions are imposed on the collector influencing safety, reliability, life, etc., by operation of the collector outside of the recommended conditions.

Each Module SEC-601 collector module contains two(2) thermocouple type temperature sensors. The junctions are located in the annulus of the collector tube element facing upward and located at the extreme left position of the module. These temperature sensors are provided for use in the system control logic. The collector module has been tested, under accelerated aging conditions, to an exit air temperature from the collector of 325°F. continuous air flow. Under extended conditions of stagnation (no fluid flow) at high levels of insolation, the collector tube elements can attain temperature levels equal to or exceeding 600°F. If air flow were initiated where the absorber tube glass temperature is at high temperature, a short term over

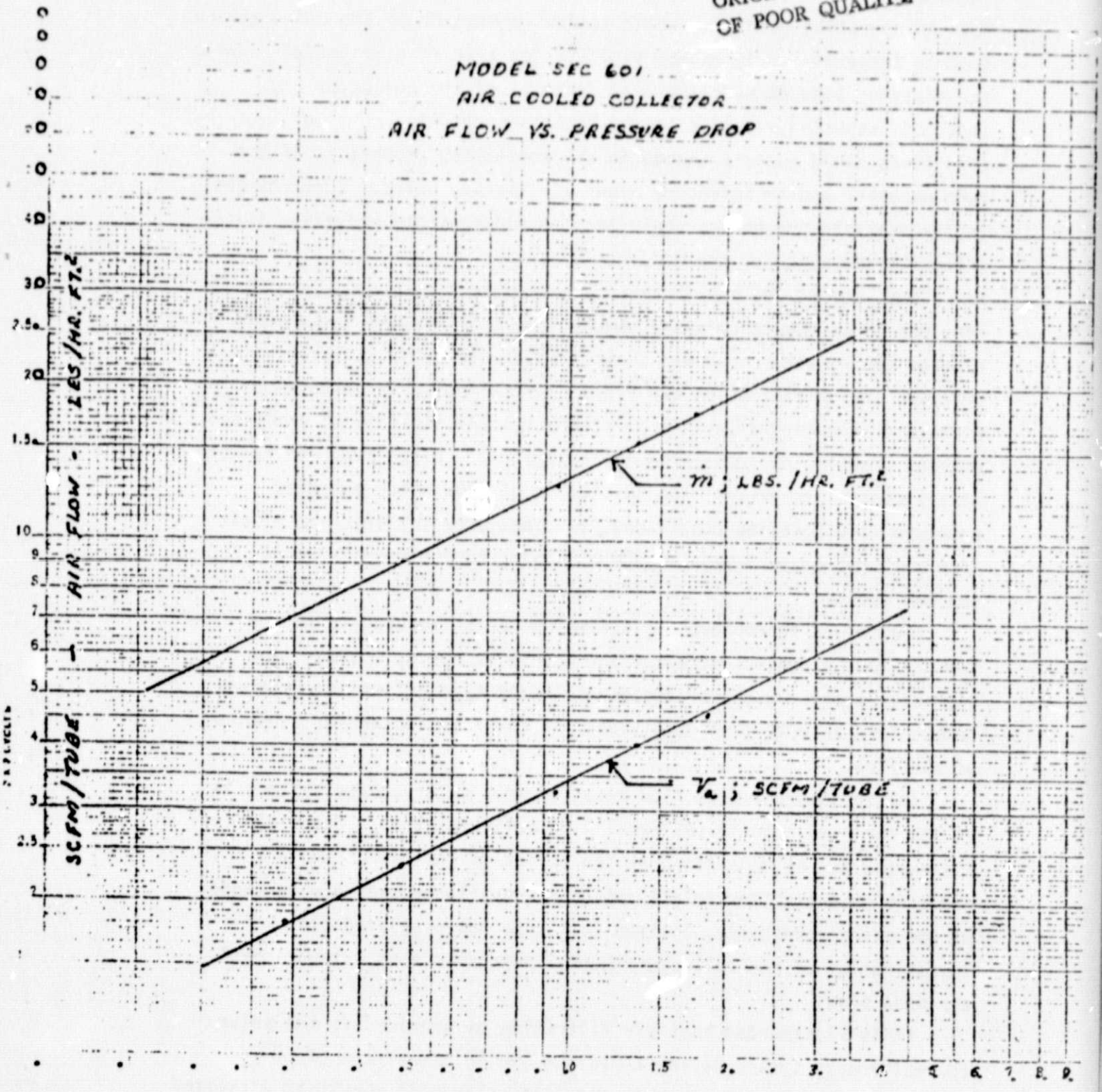


FIGURE 1

temperature excursion could be observed in the collector exit air temperature as sensible heat is removed from the absorber tubes. Such an operating condition could subject a portion of the polyurethane foam to temperatures in excess of 325°F for a short time period. While no safety or long term reliability features of the collector are impacted, repeated exposure to the high temperature excursion conditions could cause a change in the insulating properties of the foam material and/or introduce minor air leakage paths. Such changes in the manifold properties could lead to a detectable reduction in the thermal performance of the module.

Thus, one of the two thermocouples (copper-constanan, Type T) is provided as an overtemperature sensor. When the sensed temperature exceeds 450°F, electric power to the fan should be deactivated to preclude the initiation of air flow. The collector is capable of withstanding extended periods of stagnation (no fluid flow) conditions without inducing any damage to the collector. In the event of failure of the control to prevent the initiation of flow after extended exposure to stagnation conditions, the inadvertent initiation of air flow will not cause damage to the collector tube elements due to thermal shock.

The second thermocouple is provided as a temperature sensor for use in the control strategy for the solar energy system. The user may consider such strategies as temperature off set or absolute temperature as potential conditions for the starting and/or stopping of air flow.

The optimum air mass flow rate for most solar energy systems is in the range of 8 to 12 LBS/HR.FT.^{2} of collector area. Other air flow rates may be considered at the option of the user. While pressure drop-air flow relationships are available over a wide range of operating conditions, limited test time has precluded the investigation of the collector thermal performance as a function of air mass flow.

It is recommended that air filtration be provided in the solar thermal energy system having a minimum ASHRAE arrestance of 60 percent. Pressure drop through the filtration unit should be minimized (a maximum of 0.3 inches, w.g. at 150 SCFM is recommended) in order to control air pumping power requirements.

3. Maintenance Instructions.

The SUNPAK™ Model SEC-601 air cooled collector is designed for maintenance free operation over the design life (target; 20 years) of the collector. The results of accelerated aging and service life tests predict the attainment of the target design life. No routine maintenance procedures have been established or identified as required to date.

Spare Parts List:

No spare parts list for routine periodic replacement of components has been established or identified as required to date. Replacement parts will be ordered through the distributor/installer or directly from the manufacturer, Owens-Illinois, Inc., 1020 N. Westwood, Toledo, Ohio, 43606; Attention: Field Service Department.

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